IEc

MEMORANDUM | September 30, 2011

TO Sandrine Thibault, Burlington Department of Planning & Zoning

FROM Neal Etre, Angela Helman, Dan Leistra-Jones, Kristen Sebasky, and John Weiss, Industrial Economics, Incorporated

SUBJECT Executive Summary: Climate, Energy, and Green Infrastructure Analysis

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The City of Burlington, Vermont is currently in the process of developing a land use and development master plan for its downtown/waterfront area. The City envisions a plan that actively promotes climate-conscious development and transportation strategies. As a part of that process, the City's Department of Planning & Zoning (DPZ) contracted Industrial Economics, Incorporated (IEc) to conduct a Climate, Energy and Green Infrastructure Analysis. This analysis consisted of:

- Task 1: IEc assessed the City's current practices and future plans to identify potential opportunities and challenges associated with enhancing energy efficiency and green buildings, renewable energy, green infrastructure, and transportation in the downtown/waterfront area.
- Task 2: IEc developed information to assess greenhouse gas (GHG) emissions reductions that could be realized by promoting development in downtown Burlington, rather than at the suburban fringe.
- Task 3: IEc prepared three case studies of successful or promising strategies employed in other cities, focused on transportation, building energy efficiency, and green infrastructure.
- Task 4: IEc developed recommendations for the City to consider as it moves forward with its sustainability agenda.

This executive summary presents key results of IEc's work on each of these four tasks. Our intention is for DPZ to use this information as an input into the City's ongoing master planning process.

Overall, IEc found that Burlington has laid a solid foundation for advancing a robust sustainability and livability agenda. Burlington already has many sustainability and climate change policies and programs underway. Thus, the City needs to ensure that current policies and programs have the resources needed to succeed. Burlington should also be careful to undertake only those policy changes or new programs that can make a clear contribution to the City's goals, and can be sustained over time.

TASK 1: CHALLENGES AND OPPORTUNITIES FOR GREEN DEVELOPMENT IN THE DOWNTOWN/ WATERFRONT AREA

In Task 1, IEc evaluated the City's current practices and future plans to identify potential opportunities and challenges associated with enhancing energy efficiency and green buildings, renewable energy, green infrastructure, and transportation in the downtown/waterfront area.

As a first step in Task 1, IEc reviewed Burlington's development policy and planning framework. We found that Burlington's framework allows for a mix of uses in the downtown/waterfront area; that the Municipal Development Plan (MDP) action plans provide a set of tangible action items to facilitate achieving the City's goals; and that the documents recognize the importance of housing in the downtown and waterfront areas, but may overly restrict housing development. The remainder of the Task 1 memorandum focuses on four areas: green building/energy efficiency, renewable energy, green infrastructure, and transportation.

Green Building/Energy Efficiency. The City is promoting efficiency through the Burlington Electric Department (BED). BED works closely with developers to conduct energy code compliance, offer technical assistance, and provide incentives for energy efficiency. Funded by a ratepayer Energy Efficiency Charge, BED uses generous rebates as an incentive for developers to implement efficiency measures. BED also supports the development of green buildings; in several cases, BED has paid for a LEED AP to shepherd a building through the LEED accreditation process. BED is in the process of implementing a number of actions from the Climate Action Plan (CAP). These include, but are not limited to, installing "smart meters" that can help influence user behavior to reduce electricity use; implementing the Property Owners Win with Efficiency and Renewables (POWER) program, which allows for loans funded through special tax assessments; and replacing existing street lights with LEDs over a 10-year period.

Renewable Energy. Burlington has achieved modest success in the use of renewable energy, with the notable achievement being the McNeil biomass plant. The City has placed increased renewables as important action item in both MDP and CAP. The CAP actions specifically call for the implementation of several initiatives that could affect the downtown/waterfront area, including, but not limited to:

- A "Solar on Schools" program that seeks to place solar panels on seven schools.
- A renewable resource rider that would set stable rates above the retail cost of electricity to encourage the net metering of solar-generated electricity.
- A "Solar City" project that aims to install solar panels on municipal buildings.

While Burlington's solar potential (about 1,500 kilowatt-hours per square meter per year) is low compared to many parts of the nation, it still allows for successful solar installation under proper conditions.[1] Geothermal energy is another potential resource for the City to consider. The upfront costs of geothermal energy vary greatly, depending on a number of site-specific factors. It does not appear that wind will be economically viable in the downtown/waterfront area. A recent study conducted by the Carbon Trust found that small urban wind turbines are typically mounted at low heights and are not in a position to catch enough wind to generate a substantial amount of electricity. At low generation rates, the cost of electricity is very high.[2]

Green Infrastructure/Stormwater Management. Burlington created a dedicated stormwater management plan in 2009. The stormwater program is responsible for wastewater disposal permitting, project review, technical assistance, assessing user fees and credits, code enforcement, and education and outreach. At present, the Program Administrator is responsible for strategic planning, project review, NPDES permitting, technical assistance, regulatory enforcement, approving credits, and additional administrative responsibilities. By assigning all of these functions to one person, the City is likely limiting the potential reach of the stormwater program. Burlington funds the program through a user fee added to property owners' water and sewer bills. Property owners can gain credits against the user fee by implementing stormwater management techniques; however, the stormwater fee does not provide an adequate incentive for installing green infrastructure, as evidenced by the lack of credits awarded by the program to date. The ordinance provides protections that are consistent with best management practices for stormwater and erosion control.

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[1] National Renewable Energy Laboratory. "Photovoltaic Solar Potential in the United States." 2008. Available at: http://www.nrel.gov/gis/solar.html.

[2] Page, L. "Carbon Trust: Rooftop windmills are eco own-goal." The Register. August 7, 2008. Available at: http://www.theregister.co.uk/2008/08/07/rooftop_wind_turbines_eco_own_goal/page2.html.

Transportation. In March 2011, the City adopted a new transportation plan. It is too early to critically evaluate the extent to which the plan has resulted in positive changes to the transportation system, but overall, the plan appears to be well-conceived. Innovative ideas for the downtown/waterfront area include:

- Prioritizing maintenance over new road construction.
- Supporting alternative funding sources for public transit.
- Advocating the development of a downtown transportation management association (TMA) to practice Transportation Demand Management (TDM).
- Introduce market pricing concepts to the downtown/waterfront area through a pilot program.

Our evaluation identified parking as a central issue. The Comprehensive Development Ordinance sets minimum off-street parking requirements for the downtown/waterfront area. Critics contend that minimum parking requirements raise the costs of goods and housing, reduce the land available for development and increase urban sprawl, and reduce the viability of transit.[3] Business owners express concern that a lack of parking will serve as a deterrent to people using the business district. The City has recognized both sides of the debate by substantially reducing minimum parking requirements in the downtown/waterfront area, and by implementing parking maximums. However, to-date, Burlington has retained a no net loss policy on parking.

TASK 2: COMPACT DEVELOPMENT, TRAVEL PATTERNS, AND GREENHOUSE GAS EMISSIONS – LITERATURE AND METRICS

In Task 2, we reviewed key literature on the relationship between the built environment, vehicle miles traveled (VMT), energy use, and CO_2 emissions. We also identified relevant local data sources and metrics that can be used to track key environmental outcomes over time.

Researchers agree that denser areas are generally associated with lower VMT, but there is considerable disagreement as to the size of the effect. Growing Cooler estimates that doubling residential density would result in a five percent reduction in citywide VMT; a smaller change in density would result in a proportionately smaller decrease in VMT.[4] Other studies produce different estimates, but overall, the literature does not suggest that denser development, on its own, will have a major impact on citywide VMT or CO_2 emissions. Other land use factors appear to be more important than density in influencing VMT; of these, destination accessibility may be the most important (i.e., the number of jobs or other attractions reachable within a given travel time).[5] If increased density is coupled with other aspects of compact development, such as a well-balanced mix of land uses, short distances from homes to key destinations, a pedestrian-friendly street network, and accessible transit, greater savings could result than from increased density alone.[6]

On the household level, individuals or families choosing to live in a compact development are likely to have substantially lower VMT. The literature suggests that compact development options will reduce an individual's need to drive 20 to 40 percent compared to development at the outer suburban edge.[7]

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[3] For an excellent summary of the parking requirement debate, see Sherman, A. "The Effects of Residential Off-Street Parking Availability on Travel Behavior in San Francisco." San Jose State University Department of Urban and Regional Planning. May 2010. Available at: http://www.sjsu.edu/urbanplanning/docs/URBP298Docs/urbp298_HonorsReport_Sherman.pdf.

[4] Ewing, Reid et al. Growing Cooler: The Evidence on Urban Development and Climate Change. Urban Land Institute, 2008. P. 70.

[5] Ewing, Reid and Robert Cervero. "Travel and the Built Environment: A Meta-Analysis." Journal of the American Planning Association 76(3), Summer 2010. P. 275.

[6] National Research Council Transportation Research Board. "Special Report 298: Driving and the Built Environment: The Effects of Compact Development on Motorized Travel, Energy Use, and CO_2 Emissions." National Academy of Sciences, 2009. Available at: http://onlinepubs.trb.org/Onlinepubs/sr/sr298.pdf. P. 4.

[7] Ewing et al. 2008, p. 9.

Other considerations include that public transit has its own emissions that dampen savings realized by reduced automobile use. A bus using conventional fuel would need to carry an average of 11.7 passengers at all times in order to be as efficient as a group of cars.[8,9] Also, reductions in VMT produce corresponding reductions in CO_2 emissions, but the relationship is not one-to-one. Taking into account penalties from shorter trip lengths and increased congestion, both of which may result from more compact development, the literature suggests that a one percent reduction in VMT due to compact development translates into a 0.93 percent reduction in CO_2 from automobiles.[10] Because Burlington has relatively little traffic compared to larger urban areas, the observed ratio may be closer to 1.0. Using these numbers, a 30 percent reduction in VMT would translate into a 28 – 30 percent reduction in automobile CO_2 emissions for affected households. Looking forward, there does not appear to be sufficient data for Burlington officials to measure environmental benefits *caused by* changes in the City's development patterns. However, local-level data will enable officials to monitor whether changes in VMT, energy use, and CO_2 emissions are occurring *in tandem with* changes to the built environment. We recommend that Burlington use Vermont data from the National Household Travel Survey as a data source for VMT. Based on average emission rates and the adjustment factors noted above, every one VMT decreased should result in a net decrease of 0.86 – 0.93 lb. CO_2. To estimate environmental gains from public transportation, we recommend the following calculation:

EXHIBIT 1: CALCULATING ENVIRONMENTAL GAINS FROM PUBLIC TRANSPORTATION

ROW	CALCULATION STEP	CURRENT VALUE	DATA SOURCE
[1]	Total Bus Gallons (Diesel) Consumed	372,534	CCTA
[2]	/ Total Bus Passenger-Miles	Unknown	CCTA
[3]	= Bus Gallons (Diesel) per Person-Mile	[1] / [2]	Calculated
[4]	x CO_2 per Gallon (Diesel)	22.2 lb.	EPA
[5]	= Bus CO_2 per Person-Mile	[3] x [4]	Calculated
[6]	Automobile Gallons (Gasoline) per Person-Mile	0.03	U.S. Average
[7]	x CO_2 per Gallon (Gasoline)	19.4 lb.	EPA
[8]	= Automobile CO_2 per Person-Mile	[6] x [7] = 0.582 lb.	Calculated
[9]	Net CO_2 Reduction per Passenger-Mile from Riding Bus	[8] – [5]	Calculated
[10]	Total CO_2 Reduction from Riding Bus	[9] x [2]	Calculated

Development modes also impact residential building energy use. This is mainly because compact development tends to promote multi-family buildings and smaller single-family homes. Such buildings have lower volumes and outside surface area per person, resulting in lower heating and cooling loads. For example, Kockelman et al. estimated that a family moving from a 2,400 sq. ft. detached single-family home to a modestly smaller 2,000 sq. ft. apartment would save an average of 37 percent of total energy use.[11]

TASK 3: CASE STUDIES

In Task 3, IEc developed case studies of other cities that have implemented promising urban development strategies focused on alternative energy, transportation, green buildings, and/or green infrastructure. A common theme identified is the importance of ongoing communication and outreach.

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[8] Department of Energy Center for Transportation Analysis. "Transportation Energy Data Book." Edition 29, June 30, 2010. Table 2-12. Available at: http://cta.ornl.gov/data/index.shtml

[9] I.e., 39,906 Btu per vehicle-mile / (5,465 Btu per vehicle-mile / 1.6 passengers) = 11.7 passengers.

[10] Ewing et al. 2008, p. 34.

[11] Kockelman, K. et al. "GHG Emissions Control Options: Opportunities for Conservation." University of Texas, Austin, 2009. Available at: http://onlinpubs.trb.org/Onlinepubs/sr/sr298kockelman.pdf. Cited in Transportation Research Board 2009, pp. 175, 199.

Boulder, CO: Bus Passes and Municipal Parking. The EcoPass is an unlimited-use pass for yearly access to all area transit services, offered at a group discount rate. EcoPasses are available to employers to purchase for their employees to provide an incentive for taking public transit. A second type of EcoPass, the "Neighborhood EcoPass," provides a group of residents with a group rate for the EcoPass, without having to receive the pass from an employer.[12]

GO Boulder, a group within the City's Transportation Division, provides additional benefits beyond the group discount rate, including a 50 percent subsidy for the first year in the EcoPass program and a 25 percent subsidy in the second year. GO Boulder also spends approximately $1 million per year investing in transit service above what the Regional Transit District (RTD) provides. GO Boulder buses run so frequently that schedules need not be provided, making public transit an even more attractive option.

A parking program further reduces automobile use in Boulder's downtown area. The City used bonds and property taxes to build shared parking structures, install parking pay stations, and improve signage at parking garages to reduce the amount of circling to find available parking spots. A portion of the revenue generated from parking fees (about $750,000 in 2010) is used to pay for EcoPasses for all downtown employees.[13]

The major barrier the GO Boulder team faced with the EcoPass is that most of the transit system and the EcoPass itself are owned by RTD, a regional authority operating out of Denver. RTD does not support the subsidies that GO Boulder offers on the EcoPass. Three other groups needed to be convinced that the EcoPass and parking fee programs were a good idea: the Chamber of Commerce, employers, and developers. Thus, the Boulder team conducted extensive outreach to move these programs forward.

The EcoPass program has been successful in encouraging transit. The team has found that an employee or resident with an EcoPass is five to nine times more likely to take public transit compared to an individual without an EcoPass. Also, when an employer provides an EcoPass to its employees, about 38 percent of the employees will drive to work in a single occupancy vehicle, compared to 70 percent of employees that are not provided with an EcoPass.

Berkeley, CA: Municipal Building Energy Retrofits. The City of Berkeley began energy retrofits of municipal buildings in the early 1990s. This initiative is currently under the purview of the Office of Energy and Sustainable Development (OESD). OESD places a high priority on making municipal buildings more energy-efficient. Working cooperatively with the Department of Public Works, OESD staff seek to identify opportunities to incorporate energy efficiency retrofit measures into otherwise scheduled building maintenance activities. Retrofits generally include updated lighting, heating and ventilation systems, and building control systems, along with the addition of occupancy sensors for lights.

The main barrier to retrofits is funding. Retrofits can only be done when there are enough upfront funds and/or financing to support them. For large projects, the City often relies on utility rebates and financing. For example, Pacific Gas and Electric is currently offering zero percent financing for efficiency projects.

To date, the City has saved 2.1 million kWh of electricity and 37,520 therms of heat from retrofit projects in municipal buildings, for an annual savings of $370,000. Throughout implementation, OESD has found it important to coordinate with other agencies. Coordination with Public Works is particularly beneficial, and maintenance projects now routinely include consideration of energy efficiency upgrade opportunities.

Portland, OR: Stormwater Management. A "Green Street" is a street that uses vegetated facilities to manage stormwater, improve water quality, replenish groundwater, make streetscapes attractive, and improve access

[12] An overview of the EcoPass program is available at: http://www.rtd-denver.com/EcoPass.shtml

[13] Information on parking pricing can be found at: http://www.bouldercolorado.gov/index.php?option=com_content&task=view&id=899

for pedestrians and bicyclists. Portland began exploring a Green Streets initiative in 2005.[14] During Phase 1, a cross-bureau team developed a guidance document, which is now included in the City's Stormwater Management Manual.[15] The team initiated Phase 2 in 2006, during which they wrote a citywide Green Streets policy; the City Council approved this policy in 2007.

The program is funded by capital dollars and the City's general fund. Transportation enhancement projects fund some Green Street facilities, as all new city infrastructure projects are required to consider Green Streets. When new development projects have difficulty funding Green Streets, they can access Portland's "One Percent for Green" fund.[16] Construction projects within the right-of-way that fall outside the requirements of the Stormwater Management Manual are required to contribute one percent of construction costs to this fund.

Staff within the Watershed Revegetation Program visit the facilities at least twice per year to perform maintenance. In addition, through the "Green Streets Steward Program," volunteers can become "stewards" of Green Streets, providing needed maintenance such as weed removal, plant trimming, and trash cleanup.

Despite some dedicated funding sources and a volunteer maintenance corps, funding for the Green Streets program remains a challenge. In addition, the Bureau of Environmental Services (BES) experienced difficulty in identifying the best plant types to be used in Green Street facilities. BES has also found that outreach to both other agencies and the public is essential to program success; the bureau has a group of staff members specifically devoted to outreach.

Results indicate that Green Street facilities are effective, as evidenced by a 90 percent average reduction in peak flow from green infrastructure facilities and an average retention of 80 percent of rain water annually.[17] The effectiveness of individual facilities can vary according to several factors, including prior conditions, maintenance, and physical elements of the facility.

TASK 4: IMPLEMENTATION RECOMMENDATIONS

In the final task, IEc provided a set of recommendations to guide Burlington's implementation of its sustainability agenda. The key recommendations from Task 4 are as follows:

Adopt a form-based code (FBC). IEc recommends that Burlington shift its zoning code to a form-base code (FBC). FBCs use physical form rather the separation of uses as the organizing principle for development. They are prescriptive solutions that focus on identifying the types and features of development desired by the community at specific locations. Through the use of FBCs, Burlington would have more control over land use than conventional zoning, allowing the City to effectively implement policies and programs that are crucial for realizing the City's sustainability and livability goals. FBCs have been shown in many communities to be more effective than conventional zoning in realizing densities, better pedestrian orientation, and a reduction in auto dependency.[18] FBCs can also include provisions that prescribe the location and development of renewable energy, transportation nodes, and green infrastructure measures.

Reconsider current parking policies. Burlington's no net loss parking policy and off-street parking minimums are in conflict with the City's sustainability goals. To move residents towards public

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[14] Information on the Green Streets program is available at: http://www.portlandonline.com/BES/index.cfm?c=44407&

[15] The Stormwater Management Manual is available at: http://www.portlandonline.com/bes/index.cfm?c=47952

[16] Information on the fund can be found at: http://www.portlandonline.com/BES/index.cfm?a=341452&c=44407

[17] City of Portland, *Stormwater Management Facilities Monitoring Report*, December 2010, p. S-5. Available at: http://www.portlandonline.com/bes/index.cfm?c=36055&a=343463

[18] Brad Broberg. "New Kind of Zoning, Cities of All Kinds Adopting Form-Based Codes." *On Common Ground*, a publication of National Association of Realtors, Winter 2010. See also Bill Spikowski. "Form-Based Codes." *Florida Planning*, Winter 2010.

transportation for commuting and walking in the downtown area, both of which are necessary for realizing the City's GHG emission goals, the cost of parking needs to rise. Boulder, Colorado, discussed above, has raised parking fees without any apparent negative impact on downtown businesses. The current low cost of parking downtown also represents a missed opportunity to raise revenues for parking and transportation improvements. The City should also consider allowing new development to provide cash-in-lieu of parking to create additional revenue. The revenues collected through cash-in-lieu of parking and higher parking fees could fund more strategically located garage parking, and/or street design and traffic control improvements.

Changes to parking policy could be coupled with innovations such as demand-responsive meter rates and shared parking. Other cities have been successful with this approach. Redwood City, California uses demand-responsive meter rates that produce an average 18 percent availability in the downtown area. Before program implementation, these parking spaces were always occupied by day-long employees. Now, the program provides greater access for shoppers and visitors.[19]

Take steps to ensure the success of the new transportation plan. Burlington's Transportation Plan sets a preliminary goal to increase annual transit ridership by five percent annually. Increasing service frequency on key routes is an appropriate first step. The Chittenden County Transportation Authority (CCTA) notes that most of its buses provide service every 30 minutes; the key recommendation of the Burlington Transportation Plan is to establish 15-minute service on the four major routes bringing riders into Burlington. Incentives to use transit will also be important to spur additional ridership; In Burlington, the CCTA's Smart Business program could be a useful tool for encouraging transit ridership. Boulder's EcoPass program could provide a useful model for successful implementation of a similar incentive program.

Develop a re-commissioning program for the City's older building stock. Over time, building system operations may cease to work in peak condition due to wear and tear, human error, changes in building operations, weather conditions, or other reasons. Re-commissioning, which includes testing and adjusting building systems to meet the original design intent and/or optimizing systems to satisfy current needs, can yield significant energy and cost savings at the building level. At a minimum, Burlington should require City buildings and schools to undergo re-commissioning on a fixed schedule, such as every five years. For privately-owned buildings, Burlington could require or incentivize re-commissioning at the point of sale.

Develop a strategic plan for Burlington's green infrastructure initiatives, and ensure available resources to support it. Current staffing is inadequate to support the green infrastructure program, and the stormwater fee does not provide an adequate incentive for green infrastructure. To develop a strategic plan, City officials should:

- Develop a few scenarios for the size and scope of a long-term green infrastructure program.
- Analyze funding needs in terms of staffing and other operating costs for each scenario over time.
- Analyze the potential for stormwater fees and other potential revenues to meet the funding needs estimated under each scenario.

As part of this analysis, the City should examine the impacts of raising its stormwater fee. The current user fee of $1.17 per thousand square feet of impervious surface is too low to stimulate significant interest in earning green infrastructure credits. In contrast, Portland, Oregon, discussed above, charges $9.97 per

[19] Seattle Department of Transportation. "Best Practices in Transportation Demand Management." Seattle Urban Mobility Plan. January 2008. Available at: http://www.seattle.gov/transportation/docs/ump/07%20SEATTLE%20Best%20Practices%20in%20Transportation%20Demand%20Management.pdf.

thousand square feet of impervious surface for non-residential properties.[20] The City could also consider cost-sharing opportunities or low-interest loans for green infrastructure projects, such as under Philadelphia's SMIP program (briefly discussed in Task 3).

Develop an outreach and communication strategy. Burlington should invest in communication and outreach for its sustainability programs, to market the concept of a Sustainable Burlington. All stakeholders will benefit from Burlington centralizing information on its climate change and sustainability plan onto one well-designed, branded website (e.g., "LivableBurlington.gov"). The City's sustainability page should explain what the City is trying to accomplish with its sustainability plan and should provide a compelling, concise argument about how climate action, livability, and economic stability are intrinsically linked for Burlington. Boulder County, Colorado and Seattle, Washington both have sustainability sites that Burlington could use as examples.[21,22]

Additional outreach and communications efforts would also benefit the City:

- Local businesses may want information on how sustainability initiatives can improve their bottom lines by creating a more livable, vibrant, and economically stable downtown. They will also benefit from reassurance that a lack of on-site parking will not negatively impact customer traffic.
- Existing and potential community members should understand the livability benefits of a vibrant, pedestrian-friendly downtown, such as the ability to walk to work and other key destinations.
- Other City agencies may require information on how Burlington's sustainability initiatives fit into existing procedures, how they are paid for, and what the environmental benefits will be.

In addition to the key recommendations detailed above, IEc also made several additional recommendations for Burlington's agencies to consider. These include:

- Implement and maintain stricter building standards, either by keeping Burlington's energy code state-of-the-art, implementing a "stretch" code, or by mandating buildings to meet green building standards such as LEED or the International Green Construction Code (IgCC).
- Reach out to experts to obtain guidance on implementing a green historic preservation program.
- Integrate energy efficiency into the capital planning process for municipal buildings.
- Focus on energy efficiency first, with renewable energy use a secondary strategy.
- Conduct additional feasibility analyses on renewable energy, particularly solar and geothermal, and integrate the results of these analyses into the form-based code.
- Create a green roofs program to bridge information gaps and provide incentives for users.
- Work with the Parks and Recreation Department to manage urban forestry as green infrastructure.
- Review Burlington's existing transportation assumptions and performance metrics using the information provided in the Task 2 memorandum.
- Increase service frequency for the City Loop bus route.
- Consider switching the CCTA bus fleet to biodiesel.

[20] City of Portland, Oregon, Portland Bureau of Environmental Services. "Drainage/Stormwater Management User Service Charges and Discounts." Available at: http://www.portlandonline.com/bes/index.cfm?a=354259&c=55059.

[21] Boulder County. "About Sustainability." 2011. Available at: http://www.bouldercounty.org/sustain/initiative/pages/aboutsustain.aspx

[22] City of Seattle Office of Sustainability and Environment website. 2011. Available at: http://www.seattle.gov/environment/

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MEMORANDUM | September 30, 2011

TO Sandrine Thibault, Burlington Department of Planning & Zoning

FROM Kristen Sebasky, Dan Leistra-Jones, Neal Etre, and Angela Helman, Industrial Economics, Incorporated

SUBJECT Task 1: Challenges and Opportunities for Green Development in the Downtown/Waterfront Area

DISCLAIMER: The work that provided the basis for this publication was supported by funding under an award with the U.S. Department of Housing and Urban Development. The substance and findings of the work are dedicated to the public. The author and publisher are solely responsible for the accuracy of the statements and interpretations contained in this publication. Such interpretations do not necessarily reflect the views of the Government.

INTRODUCTION

The City of Burlington, Vermont is currently in the process of developing a land use and development master plan for its downtown/waterfront area. The City envisions an aggressive plan that actively promotes climate-conscious development and transportation strategies. As a part of that process, identified as Task 1 of the Climate, Energy and Green Infrastructure Analysis, the City's Department of Planning & Zoning (DPZ) has contracted Industrial Economics, Inc. (IEc) to evaluate the City's current practices and future plans to identify potential opportunities and challenges associated with enhancing energy efficiency and green buildings, renewable energy, green infrastructure, and transportation in the downtown/waterfront area.

Under this task, IEc evaluated a number of key planning documents selected by DPZ, including:

- Burlington's Comprehensive Development Ordinance;[1]
- The 2006 Municipal Development Plan;[2]
- A draft set of actions and descriptions from the City's Climate Action Plan (CAP);[3]
- Chapter 26 Wastewater, Stormwater, and Pollution Control;[4]
- Department of Public Works Stormwater Credit Manual;[5]
- Phase II Stormwater 2010 Annual Report;[6]
- Moving Forward Together: Transportation Plan for the City of Burlington;[7]

[1] City of Burlington, Vermont. Comprehensive Development Ordinance. January 2008. Available at: http://library.municode.com/index.aspx?nomobile=1&clientid=13987http://library.municode.com/index.aspx?nomobile=1&clientid=13987.

[2] City of Burlington, Vermont. 2006 Municipal Development Plan. May 2006. Available at: http://www.ci.burlington.vt.us/planning/comp_plan/municipal_development_plan/2006/mdp_2006_toc.php.

[3] "Climate Action Plan Descriptions." Provided by Sandrine Thibault, Burlington Department of Planning and Zoning, June 2011.

[4] City of Burlington, Vermont Code of Ordinances, Chapter 26 Wastewater, Stormwater, and Pollution Control. December 2008. Available at: http://library.municode.com/index.aspx?nomobile=1&clientid=13987.

[5] City of Burlington, Vermont, Department of Public Works. Stormwater Credit Manual. May 2009. Available at: http://www.dpw.ci.burlington.vt.us/docs/stormwater_credit_manual_051309.pdf

[6] City of Burlington, Department of Public Works. Phase II Stormwater 2010 Annual Report. April 2011. Available at: http://www.ci.burlington.vt.us/docs/4101.pdf.

- Burlington Downtown and Waterfront Plan Transportation Study;[8] and
- Land Use Inventory and Buildout Analysis.[9]

To better capture the context and circumstances that could pose challenges for successful implementation of specific policy actions in Burlington, IEc also participated in conference calls with several key city officials from DPZ, the Department of Public Works (DPW), Burlington Electric Department (BED), and the Parks and Recreation Department. Finally, we supplemented our research by consulting the broader literature to identify opportunities and challenges that Burlington may face during implementation.

This memorandum is organized as follows. We first present the results of our general evaluation of Burlington's existing regulatory framework and provide a brief discussion of how form-based codes could potentially facilitate the City's efforts to improve performance with respect to energy use, green infrastructure, and transportation. This is followed by specific discussions of the four focus areas of this task: energy efficiency and green buildings, renewable energy; green infrastructure; and transportation.

BURLINGTON'S DEVELOPMENT POLICY AND PLANNING FRAMEWORK

IEc reviewed the Burlington Municipal Development Plan (MDP) and the Burlington Comprehensive Development Ordinance (CDO) and other documents with a focus on the downtown/waterfront area. Together, these documents form the basic policy and planning framework for development in Burlington. The MDP serves as the City's master plan and sets the strategic vision for development. The CDO codifies the vision set forth in the MDP into development regulations. While our review targeted the provisions focused on energy, green buildings, green infrastructure, and transportation, we believe it is worthwhile to provide a brief review of the framework with respect to sustainable development in the downtown and waterfront areas. Overall, we found:

- **On balance, Burlington's policy and planning framework allows for a mix of uses in the downtown/waterfront area.** The MDP sets a strong vision for a sustainable Burlington and recognizes that the economic and cultural strength of the downtown area relies on compact, mixed-use development reflective of the City's architectural and historic heritage. The CDO permits uses and prescribes set-backs and building heights that are generally consistent with this vision. The MDP and buildout analysis suggest that opportunities exist to increase density in the downtown/waterfront area.

- **The MDP action plans (e.g., Energy Action Plan) provide a set of tangible action items to facilitate achieving the City's goals.** The scope and depth of the policy planning framework shows Burlington to be progressive with respect to sustainable development. The City is well-positioned to be a national leader on the subject, provided that the community continues follow-through on the many action plan items designated throughout out the policy documents.

- **The documents recognize the importance of housing in the downtown and waterfront areas, but may overly restrict housing development.** The CDO generally prohibits residential dwellings on the first floor and requires that no more than 50 percent of the gross floor area developed can be residential in the downtown/waterfront area.[10] Results from the Task 2 analysis suggest that increasing housing availability in the downtown/waterfront area would

[7] City of Burlington, Vermont, Department of Public Works, Department of Planning and Zoning, Community and Economic Development Office. Moving Forward Together: Transportation Plan for the City of Burlington. March 2011.

[8] RSG, Inc. Burlington Downtown and Waterfront Plan Transportation Study: Synthesis of Prior Plans and Studies. Draft June 2011.

[9] Milone and MacBroom, Inc. Land Use Inventory and Buildout Analysis of Downtown & Waterfront Area Burlington, Vermont. 2011.

[10] CDO. 4.4.1(d)1.B Residential/Nonresidential Mix Required.

provide greater opportunities for residents to reduce household-level environmental impacts and transportation costs. However, the current housing restrictions may limit the extent of potential household-level improvements, and could be in conflict with the City's greenhouse gas (GHG) reduction goals. The City may wish to reconsider the restrictions on housing in the downtown/waterfront area.

During the forthcoming master planning process for the downtown/waterfront area, Burlington will have an opportunity to further strengthen its planning and policy framework to facilitate for an even more robust commitment to sustainable development. Specifically, the City has an opportunity to shift its zoning code from conventional use-based zoning to a form-base code (FBC). FBCs use physical form rather the separation of uses as the organizing principle for development. They are prescriptive solutions that focus on identifying the types of development desired by the community at specific locations.

FBCs are typically organized by transects that travel from the most dense areas (e.g., downtown) to the least dense areas (e.g., ex-urban/agricultural areas). Each block along the transect is assigned prescribed forms for building height and character. Uses can be designated, but are secondary to the form designations. Since FBCs regulate development at the scale of an individual building or lot, they encourage independent development by multiple property owners. This eliminates the need for complex land assemblies that large projects frequently require under conventional zoning.[11] Typically organized with visual displays and concise, plain language descriptions, FBCs encourage participation of nonprofessionals in the development process. Also, FBC core elements of accessibility and transparency help foster active public participation in the planning process.[12]

Through the use of FBCs, Burlington would have more control over land use than conventional zoning, allowing the City to predictably and effectively implement policies and programs that are crucial for reducing GHG emissions and realizing the City's sustainability and livability goals. FBCs have been shown in many communities to be more effective than conventional zoning in realizing densities and better pedestrian orientation, and a reduction in auto dependency. For example, Petaluma, California used a form-based code adopted in 2003 to revitalize its downtown area of approximately four hundred acres. The City adopted the FBC specifically to respect the heritage of the city while bringing more pedestrian and economic activity into underutilized areas.

In contrast, the problem with conventional zoning is that it is a comparatively abstract and imprecise tool for realizing a community's vision, which often results in development that is uncoordinated, unintended, and lacking in adherence to a community's land use planning and sustainability goals. A recent American Planning Association article summarized the power of form-based codes by stating: "Form based codes are proving indispensable for communities that want a broad application of walkable urbanism, to make new auto dependent areas the exception rather than the norm."

FBCs can be also crafted to include provisions that prescribe the location and development of renewable energy resources, transportation nodes, and green infrastructure measures. For example, the City of Flagstaff, Arizona recently conducted a city-wide code update, in which it transformed its conventional use-based zoning to a FBC. The community expressed a strong desire for sustainability to drive the code development process. To that end, the City conducted extensive studies to understand the optimal locations for renewable energy installations (primarily wind and solar) and the types of systems (e.g.,

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[11] Form Based Codes Institute. http://www.formbasedcodes.org/. Accessed July 18, 2011.

[12] Katz. P. "Form First: The New Urban Solution Conventional Zoning." Form Based Codes Institute. November 2004. http://formbasedcodes.org/articles?page=2.

ground versus roof-based) that were appropriate along each section of the transect. A similar process was carried out with regard to stormwater management and green infrastructure, determining the appropriate locations for specific stormwater best management practices (BMPs). The studies' results were incorporated directly into the FBCs, which will reduce the need for time-consuming variance procedures and/or zoning changes to construct these installations.[13,14] Through the use of FBCs, Burlington could develop similar prescriptive zoning for a host of sustainability measures, including climate appropriate architecture, renewable energy, green buildings, transportation choices, affordable housing, and green infrastructure.

The development of FBCs will require an extensive overhaul of the City's policy and planning framework documents, and likely requires changes to processes and procedures that have been in place for decades. The City should plan on educating community members about FBCs and their benefits. Extensive outreach will be necessary to communicate these changes to residents, business owners, and the development community. It will also take patience and certain measure of political will.

CHALLENGES AND OPPORTUNITIES FOR GREEN DEVELOPMENT

The remainder of this memorandum focuses on the four areas specified under Task 1: green building/energy efficiency, renewable energy, green infrastructure, and transportation. For each topic area, we provide:

- A brief overview and evaluation of current conditions, policies, and future planning;
- A discussion of potential barriers and challenges associated with promoting sustainability in the topic area; and
- A discussion of potential opportunities for improvement within the topic area, including, where applicable, examples of communities that have attempted such changes.

Green Building/Energy Efficiency

The Burlington Electric Department (BED) is a publicly-owned electric utility that is responsible for power distribution throughout Burlington. While highly regulated by the State, BED has been given broad authority to support energy efficiency programs measures throughout the City. BED collaborates with Efficiency Vermont to provide technical assistance and financial incentives to reduce the upfront costs of energy efficiency measures.[15] BED funds its energy efficiency programs through a ratepayer Energy Efficiency Charge (EEC).

BED works closely with developers to conduct energy code compliance, offer technical assistance, and provide incentives for energy efficiency. Funded by the EEC, BED uses rebates as an incentive for developers to implement energy efficiency measures. These measures can be drawn from a standard list of preapproved products or through customized program developed with BED's assistance.[16, 17] BED incentives can extend well past 50 percent of the upfront costs of energy efficiency measures. BED also uses the energy efficiency rebate to support the development of green buildings. In several cases, BED

[13] Parolek, D. "Form-Based Codes and Sustainability: Two Case Studies." Presentation at the New Partners for Smart Growth Workshop. Charlotte, NC. February 3, 2011.

[14] For more information on the Flagstaff form-based code, see http://www.flagstaff.az.gov/index.aspx?NID=1416.

[15] For more information on Efficiency Vermont, see http://www.efficiencyvermont.com.

[16] Burlington Electric Department. "Energy Efficiency Incentives, Rebates and Information." Available at: https://www.burlingtonelectric.com/page.php?pid=62&name=ee_incentives.

[17] Personal Communication, Chris Burns, Burlington Electric Department, July 25, 2011.

has forgone traditional rebates and pooled funds to pay for a LEED AP to shepherd a building through the LEED accreditation process.[18, 19]

In addition to energy efficiency rebates, the BED is in the process of implementing a number of actions from the Climate Action Plan (CAP). These include, but are not limited to: [20]

- Installing "smart meters" that can help influence user-behavior to reduce peak-electricity use, costs, and associated emissions. BED expects the program to start in 2012.
- Implementing the Property Owners Win with Efficiency and Renewables (POWER) program which allows for loans funded through special tax assessments; property owners pay for energy efficiency improvements through their property taxes over time. The program is now looking for funding sources with the goal to be up and running in 2012.[21]
- Replacing existing street lights with LEDs over a 10-year period. A pilot project is already underway.

Despite a heavy commitment to financial incentives and these other energy efficiency programs, BED still faces challenges in convincing developers to seek green building certification or implement energy efficiency measures. It can still be difficult to convince builders to spend extra money on energy efficiency and green buildings, especially if they do not plan on owning the building for the long term. Historic buildings, which are prominent in the downtown/waterfront area, also present significant challenges to efficiency upgrades, since it can difficult to upgrade a building without affecting its character.

Based on IEc's discussions with BED and review of the policy documents, we identified several opportunities for the City to continue its substantial progress on energy efficiency and green building, including:

- **Ensure that Burlington's energy code is state of the art with regard to efficiency.** The City's energy code requires that all new commercial and significantly renovated building meet 2005 Vermont Guidelines for Energy Efficient Commercial Construction.[22] These guidelines are based on the International Energy Conservation Code (IECC) 2004 Supplement, with amendments.[23] The Vermont legislature has recently passed legislation to update the guidelines based on the 2009 version of IECC.[24] BED is awaiting a final rulemaking to formalize the update; it is expected in January 2012.[25] Thus lag has resulted in the City being slow to mandate the most up-to-date energy code. Massachusetts has confronted this problem with two

[18] Personal Communication, Chris Burns, Burlington Electric Department, July 11, 2011.

[19] A LEED AP is a trained professional that helps guide developers through the LEED certification process. For more information on LEED green building rate systems, see http://www.usgbc.org/DisplayPage.aspx?CategoryID=19.

[20] "Climate Action Plan Descriptions". Provided by Sandrine Thibault, Burlington Department of Planning and Zoning, June 2011.

[21] For an extensive discussion on the POWER program, see https://www.burlingtonelectric.com/page.php?pid=141&name=Burlington%20POWER%20Program%20(CEAD).

[22] City of Burlington Code of Ordinances, 8-101 Conservation Standards.

[23] Database of State Incentives for Renewables & Efficiency. "Vermont Building Energy Standards." Available at: http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=VT07R&re=1&ee=1.

[24] Overall, the 2009 IECC standard has higher insulation requirements and higher energy efficiency requirements for heating, ventilating and air-conditioning (HVAC) equipment. Huang, Y. and K. Gowri. "Analysis of IECC (2003, 2006, 2009) and ASHRAE 90.1-2007 Commercial Energy Code Requirements for Mesa, AZ." Prepared for the US Department of Energy. February 2011. Available at: http://www.mesaaz.gov/sustainability/pdf/MesaFinalCommercialReportFeb2011.pdf.

[25] Personal Communication, Chris Burns, Burlington Electric Department, July 25, 2011.

approaches that Burlington could consider to keep the City on the leading edge of energy efficiency:

- *Keep Burlington's energy code state-of-the-art*. Rather than wait for legislative action, the City could amend the code to pin to the latest version of IECC. An updated version of IECC is expected in 2012 (they typically run in 3-year cycles). Similarly, the Massachusetts Green Communities Act of 2008 requires that the State update its building code every three years to be consistent with the most recent version of IECC.[26]
- *Implement a "stretch" code.* Stretch codes provide an avenue to improve efficiency by emphasizing energy performance, as opposed to the prescriptive mandates. Typically, a stretch code requires performance that goes beyond performance under existing code. In Massachusetts, communities that choose to employ the stretch code must build 20 percent more energy efficient than the base energy code.[27] The State estimates that the additional construction costs resulting from the stretch code runs approximately $3,000 for a typical single-family home and 1 to 3 percent of total costs for commercial buildings.[28]

- **Require buildings in the downtown/waterfront area meet LEED standards.** Current green building incentives allow for bonus height if the building is certified as LEED Silver or higher. Buildings that achieve LEED Silver can attain an extra floor (10-feet of height); LEED Gold or Platinum receives an extra two floors (20-feet of height). While this incentive is significant, the City may wish to push beyond the incentive stage and require that new or renovated buildings of significant size meet LEED standards in the downtown/waterfront area.[29] Numerous communities throughout the U.S. have taken this approach. Examples include Boston, Los Angeles, Dallas, and Washington, DC. Given the expense associated with certification, these cities opted not to require formal certification; rather, city code officials typically evaluate documentation of a building's LEED characteristics before granting final occupancy permits. Some cities, such as Los Angeles, expressed concern that requiring formal certification could create legal challenges and open them up to lawsuits, since building permits or occupancy certificates would be contingent on judgments made by the U.S. Green Building Council (USGBC), which administers LEED. [30] Alternatively, City could also choose a more stringent route and require formal LEED certification. This approach is less commonly employed, and

[26] Massachusetts Executive Office of Energy and Environmental Affairs. "Building Energy Codes." Available at: http://www.mass.gov/?pageID=eoeeaterminal&L=4&L0=Home&L1=Energy%2c+Utilities+%26+Clean+Technologies&L2=Energy+Efficiency&L3=Policies+and+Regulations+for+Energy+Efficiency&sid=Eoeea&b=terminalcontent&f=doer_Energy_Efficiency_Building_energy_Codes&csid=Eoeea.

[27] Massachusetts Executive Office of Energy and Environmental Affairs. "Building Energy Codes." Available at: http://www.mass.gov/?pageID=eoeeaterminal&L=4&L0=Home&L1=Energy%2c+Utilities+%26+Clean+Technologies&L2=Energy+Efficiency&L3=Policies+and+Regulations+for+Energy+Efficiency&sid=Eoeea&b=terminalcontent&f=doer_Energy_Efficiency_Building_energy_Codes&csid=Eoeea.

[28] Massachusetts Executive Office of Energy and Environmental Affairs. "Stretch Appendix to the Building Energy Code in Massachusetts Question and Answer (Q&A) – October 2010. " October 2010. Available at: http://www.mass.gov/Eeops/docs/dps/inf/stretch_energy_code_qa_oct11_10.pdf.

[29] Note that, in this memorandum, we discuss LEED certification as it is the most well-known green building certification program in the United States. The City, if it desires, could investigate other green building certification options, such as International Green Construction Code (IgCC). The Task 4 memorandum provides the advantages and disadvantages associated with LEED and several other green building standards.

[30] Wendt, A. "Cities Mandate LEED But Not Certification. GreenSource. July 30, 2008. Available at: http://greensource.construction.com/news/080730CitiesMandateLEED.asp.

typically has been applied to municipal buildings.[31] If the City moves forward with either of these approaches, it may face opposition from the development community, particular those builders that are unfamiliar with the LEED process. Furthermore, the additional costs associated with meeting LEED standards could drive some potential developers out the market.

- **Implement innovative green building incentives.** As a stand-alone program, or in conjunction with a green building standards requirement (see above), the City may consider implementing additional incentives for green building development beyond the density bonus. The U.S. Green Building Council (USGBC), administrators of the LEED standards, has compiled list of innovative incentives used by cities to encourage building to the LEED standards. Notable examples of green building incentives include: expedited permitting, property tax credits and abatements, grants and low interest loans, fee reductions and waivers, and free technical assistance.[32] Note that the City could apply many of these same techniques to encourage renewable energy development.
- **Develop a re-commissioning program.** Another challenge associated with green building and energy efficiency programs is maintaining building performance over time. The City's current energy efficiency programs primarily focus on achieving efficiencies at the time of construction and commissioning. Over time, systems operations may cease to work in peak condition due to typical wear and tear, human error, weather conditions, or other reasons. Re-commissioning (also known as retro-commissioning) includes testing and adjusting building systems to meet the original design intent and/or optimizing systems to satisfy current operational needs.[33] The process can yield significant energy and cost savings at the building level. For example, in 2004, Xcel Energy conducted a re-commissioning of a 500,000 square-foot older hotel in Bloomington, Minnesota. The process, which cost $340,000, found a number of ways to improve the efficiency of the HVAC system, earning $40,000 in energy efficiency rebates. Those rebates, along with estimated energy savings of 495,000 kilowatt-hours per year, resulted in a relatively short payback period of 2.3 years.[34] The City may wish to consider developing a program that provides incentives for or requires re-commissioning.
- **Investigate the potential for creating an energy efficiency program for historic buildings.** The downtown/waterfront area features many historic buildings. BED faces significant hurdles, as the energy code exempts historic buildings from energy efficiency requirements.[35] The U.S. EPA and others have created initiatives that could provide insight on potential strategies for retrofitting historic buildings. These include:
    - EPA, HUD, and DOT are providing technical assistance to Concord, New Hampshire to work with community officials, local developers, and other stakeholders to determine how historic preservation and green building approaches can best be integrated into existing building codes. One goal of the project is to

[31] USGBC. "Summary of Government LEED® Incentives" March 2009. Available at: http://www.usgbc.org/ShowFile.aspx?DocumentID=2021.

[32] USGBC. "Summary of Government LEED® Incentives" March 2009. Available at: http://www.usgbc.org/ShowFile.aspx?DocumentID=2021.

[33] Similarly, continuous commissioning™, a more costly option, utilizes integrated equipment and computers to constantly monitor and adjust building operations to meet peak performance. U.S. Department of Energy. "Federal Energy Management Program." Available at: http://www1.eere.energy.gov/femp/program/om_comtypes.html.

[34] Xcel Energy, Inc. "Recommissioning." January 2010. Available at: http://www.xcelenergy.com/staticfiles/xe/Marketing/Case-Study-RCx-hotel.pdf.

[35] Personal Communication, Chris Burns, Burlington Electric Department, July 11, 2011.

provide guidance on the how to design a regulatory framework that supports the sustainable, green redevelopment of historic buildings. Outcomes from this project could assist Burlington in amending its code to account for historic properties.[36]

  - EPA conducts an annual symposium with government agencies, nonprofit organizations, academic institutions, and experts in the fields of historic preservation and green building to discuss how to sustainably retrofit existing buildings. The outcomes of the symposia (to be available on EPA's Region 5 website) could provide policy and implementation strategies that combine green building and historic preservation.[37]
  - The Advisory Council of Historic Preservation has developed guidance on integrating sustainability with historic preservation for federal buildings. The guidance document provides a wealth of strategies, case studies, and other sources from which Burlington could draw lessons.[38]
  - The City of Boulder, Colorado has developed a suite of materials targeting energy efficiency in historic buildings, with detailed technical guidance. Burlington may wish to investigate Boulder's approach to determine whether it could be translated to Burlington.[39]

Renewable Energy

BED has established an ambitious goal of 100 percent of its generation needs from renewable sources by 2012.[40] Thus far, Burlington has achieved modest success with regard to the use of renewable energy, with the notable achievement being the McNeil biomass plant. The City has placed increased renewables as important action item in both MDP and CAP.[41] The MDP energy action plan calls for BED to conduct a study evaluating the citywide potential for, constraints of, and impacts associated with renewable energy generation, including fuel cell, cogeneration, biomass, solar, geothermal, hydro, wind, and methane.[42] BED has not formally conducted these studies; however, information regarding market impacts of renewables is available through BED's latest integrated resource plan (IRP).[43] The CAP actions specifically call for the implementation of several initiatives that could affect the downtown/waterfront area, including, but not limited to:

- A "Solar on Schools" program that seeks to place solar panels on seven schools, in partnership with a private, third-party developer that can take advantage of federal and state tax credits.

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[36] U.S. Environmental Protection Agency. "Smart Growth and Sustainable Preservation of Existing and Historic Buildings." Available at: http://www.epa.gov/smartgrowth/topics/historic_pres.htm.

[37] U.S. Environmental Protection Agency. "Region 5 Brownfields." Available at: http://www.epa.gov/R5Brownfields/.

[38] Advisory Council on Historic Preservation. "Sustainability and Historic Buildings. May 2011. Available at: http://www.achp.gov/docs/SustainabilityAndHP.pdf.

[39] City of Boulder, Colorado. "Historic Building Energy Efficiency Guide." Available at: http://www.bouldercolorado.gov/index.php?option=com_content&task=view&id=8217&Itemid=22.

[40] Burlington Electric Department. "Power Supply: BED's Power Supply for 2010." July 14, 2011. Available at: https://www.burlingtonelectric.com/page.php?pid=128&name=BED%27s%20Power%20Supply

[41] Note that the CDO is relatively silent regarding the development of renewable resources at the building level. Section 6.2.2(e) of the CDO provides language in the review standards that support the use of renewable resources and calls for site planning to take advantage of potential wind, water, or solar resources. Additionally, Section 12.1.3 provides specific variance procedures to allow renewable resource structures.

[42] MDP VIII-8 Energy Action Plan

[43] Burlington Electric Department. "2008 Integrated Resource Plan." 2008. Available at: https://www.burlingtonelectric.com/ELBO/assets/BURLINGTON%20IRP%202008%20REPORT.pdf.

- A renewable resource rider that would set stable rates above the retail cost of electricity to encourage the net metering of solar-generated electricity.
- A "Solar City" project that aims to install solar panels on municipal buildings.

Aside from the Solar on Schools program, which in progress, many of the suggested CAP actions associated with renewables are in the very early stages.[44]

As suggested above, the City could develop FBCs to guide the placement and installation of renewables at the property level. A key challenge to incorporating renewables into FBCs is developing a deep understanding of the energy resources and equipment types that makes economic and physical sense for the area. Without this information, the City could potentially permit improper siting of renewables. With this in mind, IEc examined the physical and economic factors that may affect the siting of renewable energy resources in Burlington, and specifically those resources that have been identified as having potential applications in the downtown/waterfront area – solar, wind, and geothermal energy. We based our evaluations on a high-level literature review. The City may wish to consider a more extensive review to determine the site locations, technologies, and renewable resources that are most viable for renewable energy production.

- **Solar has shown some potential in the downtown/waterfront area.** The National Renewable Energy Laboratory estimates that the solar potential in Burlington is approximately 1,500 kilowatt-hours per square meter per year. While this output is relatively low compared to many parts of the nation, it still allows for successful solar installation under the right conditions.[45] Sites that make good candidates for solar typically have access to sunshine for all or most of the day, and have the available roof or ground space adequate to house a PV array large enough to supply energy to the building.[46] Thus far, based on the CAP actions, the City has shown the most interest in the installation of solar power. BED has also indicated that the net-metering of solar power may help reduce peak loads during the summer.[47] The City has had success with the installation of solar photovoltaic (PV) arrays and solar hot water heaters, with at least 28 solar roofs installed – some of which are the downtown/waterfront area.While installation and generation costs fluctuate due geography, technology, and installation requirements, once estimate places the cost of installed solar panels range from $7 to $9 per watt (including installation); therefore a 5 kilowatt system would cost between $35,000 and $45,000. Payback on solar varies, based on rebates, tax credits, the amount electricity generated by the system, and current average price of electricity; however, it is not uncommon for periods to extend beyond 10 years.[48] Depending on incentives offered by BED, this type of system may be out of reach for many in downtown/waterfront area.
- **Wind energy is unlikely to be economically viable in the downtown/waterfront area.** The City has expressed some interest in exploring the viability of local wind energy within the

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44 Personal Communication, Chris Burns, Burlington Electric Department, July 11, 2011.

45 National Renewable Energy Laboratory. "Photovoltaic Solar Potential in the United States." 2008. Available at: http://www.nrel.gov/gis/solar.html.

46 U.S. Department of Energy. "Considering a Small Solar System." 2011. Available at: http://www.energysavers.gov/your_home/electricity/index.cfm/mytopic=10750.

47 Personal Communication, Chris Burns, Burlington Electric Department, July 11, 2011.

48 Devlin, L. "How Much Does It Cost to Install Solar on an Average US House?" Solar Power Authority. January 30, 2008. Available at: http://solarpowerauthority.com/how-much-does-it-cost-to-install-solar-on-an-average-us-house/.

downtown/waterfront area. A debate exists in the literature regarding the effectiveness of small urban wind projects. A recent study conducted by the Carbon Trust found that small urban wind turbines are typically mounted at relatively low heights and are not usually in a position to catch enough wind to generate a substantial amount of electricity. At low generation rates, the cost of electricity becomes very high. The researchers also found that the carbon footprint associated with manufacturing, shipping, installing, and maintaining small urban wind turbines can be greater than GHG emissions from energy production at local power stations.[49, 50]

The average annual wind speed at 80 meters above ground in Burlington is about 5.0 to 5.5 meters per second, while a wind speed of 6.5 meters per second is typically needed for effective turbines.[51] At Burlington's wind speeds, it is likely that any wind project would have a very long payback period, unless significant grants or rebates are available. A number of new small wind turbine technologies have emerged in recent years, but few studies measure their effectiveness in urban settings. It may be beneficial for Burlington to defer the pursuit of wind energy until it can be reliably demonstrated in urban settings similar to the downtown/waterfront area.

- **Geothermal requires additional study to determine whether it is viable in the downtown/waterfront area.** Geothermal energy is the heat energy from the Earth's core. It can be used in place of fossil fuels for heating and cooling, or generating electricity. In the United States, most of the geothermal capacity lies in the western states due to the convergence of tectonic plates in that region. However, high, steady temperatures can be found anywhere from 10 to a few hundred feet underground. For Burlington's purposes, ground source heat pumps may be the most applicable use of geothermal energy, which only requires drilling a few feet into the ground to reach areas that maintain a temperature of 50-55 degrees Fahrenheit. Ground source heat pumps are used to heat and cool buildings by pumping air or anti-freeze liquid through underground pipes situated in loops. In the summer, the heat from buildings is transported underground and in the winter, heat is brought back into the building.[52]

  The upfront costs of geothermal energy vary greatly, depending on a number of factors, including site geology, property size, building size, system type, well depth, and the potential updates necessary to make the building capable of handling geothermal energy (typically older buildings need new insulation).[53] Drilling is typically the highest expense, depending whether the system requires a vertically deep well (common for small properties) or whether the loops can be arranged horizontally in a shallow well (requires more area). The cost of drilling also

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[49] Page, L. "Carbon Trust: Rooftop windmills are eco own-goal." The Register. August 7, 2008. Available at: http://www.theregister.co.uk/2008/08/07/rooftop_wind_turbines_eco_own_goal/page2.html.

[50] Researchers at the Wind Energy Integration in the Urban Environment (WINEUR) have demonstrated that under the right conditions, small-scale urban wind can produce economically viable power; however, they call for turbine mast or building height that are 50 percent taller than the surrounding buildings. These conditions are unlikely in the downtown/waterfront area of Burlington. Wind Energy Integration in the Urban Environment. "Urban Wind Turbines: Guidelines for Small Wind Turbines in the Built Environment." February 2007. Available at: http://www.urbanwind.net/pdf/SMALL_WIND_TURBINES_GUIDE_final.pdf.

[51] California Energy Commission Consumer Energy Center. "Geothermal or Ground Source Heat Pumps. Available at: http://www.consumerenergycenter.org/home/heating_cooling/geothermal.html.

[52] Union of Concerned Scientists. "How Geothermal Works." Available at: http://www.ucsusa.org/clean_energy/technology_and_impacts/energy_technologies/how-geothermal-energy-works.html.

[53] A brief internet search showed costs of geothermal for a single-family home ranging from $4,000 upwards of $30,000.

varies depending on the terrain and other local conditions.[54] The U.S. Department of Energy found that typical payback periods on geothermal ranges from 8 to 12 years, although tax credits and other incentives can reduce the payback period to 5 years or less.[55] Given the importance of local geology, the potential for installation of geothermal in Burlington is likely site specific. If the City is interested in promoting geothermal energy, BED may wish to consider conducting a formal study to better understand the potential of geothermal resources in Burlington.

Another renewable energy resource that has been considered in Burlington is the potential development of district heating from the McNeil Generating Station. The station is jointly owned by BED, Central Vermont Public Service, Vermont Public Power Supply Authority, and Green Mountain Power. The district heating system would distribute waste heat from the wood-burning electricity plant to businesses and residences in the downtown/waterfront area. District heating for Burlington would reducing fossil fuel burning (99 percent of heating in the City comes from burning natural gas) and corresponding GHG emissions.[56] Successful district heating projects have been built across the country including St. Paul, Minnesota and Jamestown, NY.[57] Notably, Montpelier, Vermont recently received a large U.S. Department of Energy grant to extend district heating from a similar wood-fired plant to its downtown area.

A number of district heating feasibility studies have been conducted during the last 20 years, as interest in the project has ebbed and flowed over time. Recently, public interest in district heating has peaked, and a new feasibility report is nearly complete. The report will look at economic viability of several alternative distribution systems. If the City determines to move forward with the concept, it will need to contend with the following challenges:

- Raising capital, as the project promises significant initial costs.
- Long-term economic viability (i.e., costs of the cogenerated heat distribution versus natural gas).
- The logistics associated with installing and maintaining the distribution system and building-level heating equipment in the downtown/waterfront area.
- The development of management entity to run the system. It is anticipated that non-profit entity will be formed to interface with plant managers, oversee the distribution network, market the program, and carry out maintenance.

Green Infrastructure/Stormwater Management

As detailed in Chapter 26 of the Burlington Code of Ordinances, the City created a dedicated stormwater management plan in 2009. The plan establishes minimum stormwater runoff requirements and erosion controls to protect the public, Lake Champlain, and its tributaries.[58] The stormwater program is responsible for wastewater disposal permitting, project review, technical assistance, assessing user fees

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[54] Union of Concerned Scientists. "How Geothermal Works." Available at: http://www.ucsusa.org/clean_energy/technology_and_impacts/energy_technologies/how-geothermal-energy-works.html.

[55] U.S. Department of Energy – Oak Ridge National Laboratory. "Geothermal (Ground-Source) Heat Pumps: Market Status, Barriers to Adoption, and Action to Overcome Barriers." December 2008. #ORNL/TM-2008/232.

[56] Personal Communication, Chris Burns, Burlington Electric Department, July 25, 2011.

[57] Montpelier, Vermont. "District Energy Project." June 2011. Available at: http://www.montpelier-vt.org/community/99.html.

[58] City of Burlington, Department of Public Works. Phase II Stormwater 2010 Annual Report Section 26-1. April 2011. Available at: http://www.ci.burlington.vt.us/docs/4101.pdf.

and credits, code enforcement, and education and outreach.[59] Burlington funds the stormwater program through a user fee added to property owners' water and sewer bills. The fee has been set to a parcel's impervious surface area (per thousand square feet) times a rate determined by the Burlington City Council.[60] Property owners can gain credits against the user fee for implementing stormwater and pollutant management techniques that meet specified thresholds for water retention and/or water quality improvements.[61] Both traditional stormwater BMPs (e.g., retention basins) and green infrastructure techniques (e.g., rain barrels, green roofs, infiltration, and water reuse) can be employed to earn credit.[62]

The new ordinance was developed through a public process that carefully considered existing Vermont law and opportunities to improve environmental protection.[63] By creating a dedicated and separately funded stormwater and erosion program, the City has taken an important step to improve its stormwater management. The ordinance provides protections that are consistent with best management practices for stormwater and erosion control. The Stormwater Management Program Administrator is now in the process of implementing the regulations. The implementation of the program continues as a learning experience, as the City expects to adapt the program over time. [64]

Thus far, stormwater management efforts in the downtown/waterfront area have focused on slowing runoff and reducing pollutant loadings to Lake Champlain and tributaries. This goal is appropriate as the downtown/waterfront area already contains a significant quantity of impervious surface from roads, sidewalks, and roofs. With the potential for increased density resulting from the downtown and waterfront master plan, slowing runoff will continue to be a challenge for the program.[65] The stormwater program also faces significant challenges in convincing developers and property owners throughout the downtown/waterfront area to install green infrastructure measures.

Based on IEc's discussions with the Stormwater Management Program Administrator and our review of the regulations and supporting documents, we identified several opportunities that could improve the program and increase the application of green infrastructure in the downtown/waterfront area, including:

- **Hire additional Stormwater Management Program staff.** Currently, the program is staffed by the Administrator and occasional assistance from DPW staff. The Administrator is responsible for strategic planning, project review, NPDES permitting, technical assistance, regulatory enforcement, approving credits, and additional administrative responsibilities. By assigning all of these functions to one person, the City is likely limiting the potential reach of the stormwater program. Discussions with the Administrator indicate that dedicating time to enforcement has been difficult. In some cases, the heavy workload on the Administrator has made it necessary to prioritize the development projects that receive technical assistance;

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[59] City of Burlington, Department of Public Works. Phase II Stormwater 2010 Annual Report. April 2011. Available at: http://www.ci.burlington.vt.us/docs/4101.pdf.

[60] Detached single-, two-, and three-family homes are allocated imperious surface based on the average within each category. For example, the average detached single-family home in Burlington has 2,670 square feet of impervious surface; therefore, users pay 2.67 times the user fee rate. See Section 26-172 for more information.

[61] City of Burlington, Department of Public Works. Phase II Stormwater 2010 Annual Report Section 26-173. April 2011. Available at: http://www.ci.burlington.vt.us/docs/4101.pdf.

[62] City of Burlington, Vermont, Department of Public Works. Stormwater Credit Manual. May 2009. Available at: http://www.dpw.ci.burlington.vt.us/docs/stormwater_credit_manual_051309.pdf.

[63] Personal communication, Megan Moir, Burlington Department of Public Works. July 25, 2011.

[64] Personal communication, Megan Moir, Burlington Department of Public Works. July 25, 2011.

[65] Note that increased densification in the downtown/waterfront area does not necessarily mean an increase in impervious surface and stormwater runoff will occur. If the master plan results in taller buildings (with similar footprints) on previously developed lots, rather than increases in pavement, the quantity of impervious surface should remain similar.

therefore, the City may have missed opportunities to apply creative solutions to stormwater issues at lower priority sites.66 The City may wish to consider adding a full-time staff person with technical qualifications to oversee technical assistance, project review, and permitting processes. This arrangement could free the Administrator to focus on strategic planning, outreach, program implementation, enforcement, and other responsibilities. Adding a new staff member likely requires additional program funding, which could be generated through an increase in the user fee (discussed further below). As green infrastructure involves several City departments beyond DPW, additional staff member from other departments (e.g., Parks and Recreation) may also be useful to support the Stormwater Management Program.

- **Increase user fees to generate additional funding and stimulate interest in green infrastructure credits.** The current monthly stormwater user fee is $1.17 per thousand square feet of impervious surface.[67] A typical owner of a commercial lot with 20,000 square-feet of impervious surface pays a fee of $23.40 per month. This relatively small fee gets buried within the larger water and sewer bill. As constructed, the user fee is too low to stimulate significant interest in earning green infrastructure credits, as evidenced by the lack of credits awarded by the program. As of the time of writing, only four green infrastructure credits have been awarded, and none have been granted in the downtown/waterfront area. Increasing the user fee would likely make credits a more attractive option for property owners, particularly if it was paired with additional outreach to ensure that property owners understand the credit process. A number of cities have implemented stormwater use fees that are substantially higher than those in Burlington. For example, Portland, Oregon charges $9.97 per thousand square feet of impervious surface for non-residential properties.[68] Note that raising the user fee would likely spawn some level of opposition from residents and business owners concerned about rising costs. If the City raises the user fee, it could consider additional waivers or discounts to assist those with financial difficulties.
- **Develop additional funding opportunities for green infrastructure.** The City could consider developing cost-sharing opportunities or low-interest loan programs to help fund green infrastructure projects. For example, Task 3 presents a short case study on Philadelphia's Stormwater Management Incentives Program (SMIP), where commercial property owners can receive low-interest loans for stormwater management projects. Funded by the local water utility, loan amounts range from $75,000 to $1,000,000 with a one percent fixed interest rate. The loan term is up to 15 years, consistent with the payback period for stormwater management measures.
- **Create a green roofs initiative.** Green roofs are made of dense vegetation planted on the roofs of buildings. They are designed to reduce the stormwater impacts of development through the detention and retention of stormwater. A recent EPA study indicates that the green roofs are capable of removing 50 percent of the annual rainfall volume from a roof through retention and evapotranspiration. Rainfall not retained by green roofs is detained, effectively increasing the

[66] Personal communication, Megan Moir, Burlington Department of Public Works. July 25, 2011.

[67] Personal communication, Megan Moir, Burlington Department of Public Works. July 8, 2011.

[68] City of Portland, Oregon, Portland Bureau of Environmental Services. "Drainage/Stormwater Management User Service Charges and Discounts." Available at: http://www.portlandonline.com/bes/index.cfm?a=354259&c=55059.

time to peak, and slowing peak flows for a watershed.[69] Section 26-157 of the Burlington City Ordinance encourages green infrastructure practices, including green roofs. However, the regulations are silent with regard to appropriate use and application of green roofs in the City. Currently, the City approves green roofs (along with several other green infrastructure measures) on a case-by-case basis.[70] Local property owners have expressed in interest in green roofs, with over a dozen built in the City to date.

General impediments to green roofs in Burlington include the lack of familiarity with the technique, difficulty locating technical expertise, and installation and maintenance costs.[71, 72] A green roofs initiative could help bridge some of the information gaps, bring together interested parties with experts and advocates, and provide incentives through user fee credits/abatement or other green infrastructure funding mechanisms (such as loans and grants). For example, Cincinnati has dedicated an estimated $5 million per year in below-market-rate loans from the U.S. Environmental Protection Agency's Clean Water State Revolving Fund to cover the incremental cost of adding a green roof to a new or existing building.[73]

- **Consider urban forestry as green infrastructure.** Urban street trees provide significant stormwater management benefits.[74] They also face tremendous stress from inadequate soils, pollution, and human interference, which can dramatically reduce life span. They require regular maintenance and attention which can be resource intensive and time consuming. Burlington's urban forestry program is the responsibility of the Parks and Recreation Department, and is funded through the general fund and a dedicated tax built into local property taxes at $0.0026 per $1.00.[75] The Department is in the midst of conducting a new urban tree inventory, which will identify the location, ages, species, health of Burlington's nearly 10,000 trees, including those in the downtown/waterfront area. This inventory is the first step in the updating the urban forestry master plan and street tree planting plan.[76] The Stormwater Management Program could leverage and provide input into these plans to ensure that the planting strategies maximize stormwater retention in the downtown/waterfront area. This option would require close collaboration between DPZ and Parks and Recreation, including sharing GIS data on the street tree inventory and existing stormwater management measures.

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[69] U.S. EPA. "Green Roofs for Stormwater Runoff Control." February 2009. EPA/600/R-09/026. Available at http://www.epa.gov/nrmrl/pubs/600r09026/600r09026.pdf.

[70] City of Burlington, Vermont. Comprehensive Development Ordinance. January 2008. Available at: http://library.municode.com/index.aspx?nomobile=1&clientid=13987http://library.municode.com/index.aspx?nomobile=1&clientid=13987.

[71] Cost estimates for green roofs range widely, ranging from $6 per square-foot to over $40 square-foot, based on the size of the roof, new construction versus an existing building, method of installation, and roof type. U.S. EPA. "Green Roofs for Stormwater Runoff Control." February 2009. EPA/600/R-09/026. Available at http://www.epa.gov/nrmrl/pubs/600r09026/600r09026.pdf.

[72] Personal communication, Mark Eldridge, Green roof advocate, July 8, 2011.

[73] City of Cincinnati. Office of the City Manager. Green Roof Program. Available at: http://www.cincinnati-oh.gov/cmgr/pages/-38098-/.

[74] Street trees also provide additional benefits, including pollutant removal, cooling, wildlife habitat, safety, and aesthetics. The USDA estimates that over a 50-year lifetime, a street tree generates $31,250 worth of oxygen, provides $62,000 worth of air pollution control, recycles $37,500 worth of water, and controls $31,250 worth of soil erosion. USDA Forest Service Pamphlet #R1-92-100. For a thorough discussion on the benefits of street trees, see Burdan, Dan. "22 Benefits of Urban Street Trees." May, 2006. Available at: http://www.ufei.org/files/pubs/22BenefitsofUrbanStreetTrees.pdf.

[75] City of Burlington, Vermont. "Resolution Relating to Annual Tax Assessments on the Property Grand List of the City for the Purposes therein Set Forth for the Fiscal Year Beginning July 1, 2011." Available at: http://www.ci.burlington.vt.us/docs/4846.pdf.

[76] Personal communication, Warren Spinner, Burlington Parks and Recreation Department, July 25, 2011.

Transportation

In March 2011, the City adopted a new transportation plan. The plan reaffirms the community's vision for the Burlington transportation system and recognizes the connections among transportation, economic vitality, active living, the environment, and safety. The plan reinforces the concept of Complete Streets, a multi-modal approach that provides for transit, pedestrian access, biking, and automobiles. The plan also identifies a policy agenda and specific capital needs in its five-year plan. Innovative ideas for the downtown/waterfront area captured in the plan include, but are not limited to:[77]

- Prioritizing maintenance over new road construction.
- Supporting alternative funding sources for public transit.
- Advocating the development of a downtown transportation management association (TMA) to practice Transportation Demand Management (TDM).[78]
- Introduce market pricing concepts to the downtown/waterfront area through pricing pilot program.

The Transportation Plan required public input and careful consideration of the City's needs. Given its recent adoption, it is too early to critically evaluate the extent to which the plan has resulted in positive changes to the transportation system. Since follow-through on its policy and planning objectives is critical, the City has developed a series of performance metrics against which its progress can be measured over time.[79] Overall, the plan appears to be well-conceived, and should serve as guidepost as the City attempts to modernize and transform its transportation network over the next few years.

The Transportation Plan sets a preliminary goal to increase annual transit ridership by five percent.[80] With the implementation of the additional transit services advocated by the Plan, the goal will increase gradually over time. Beyond extra service, the City could consider incentive programs to spur additional ridership through subsidies and discounts. Under Task 3, IEc details Boulder, Colorado's efforts to increase transit ridership through its EcoPass program, which provides discount bus passes and additional perks for employees and neighborhood groups. Surveys by the transit operator have shown that an employee or resident with an EcoPass is five to nine times more likely to take public transit compared to an individual without an EcoPass. Also, when an employer provides an EcoPass to its employees, about 38 percent of the employees will drive to work in a single occupancy vehicle (SOV), down from 70 percent of employees when EcoPass is not provided. In Burlington, the CCTA's Smart Business program could be a useful tool for encouraging transit ridership. Similar to Boulder's employee EcoPass program, one current option of the Smart Business program is for businesses to purchase monthly passes for their employees for all CCTA buses. The program also includes a guaranteed ride home in case of emergency. Our research suggests that the City does not actively promote this program.

Parking is core issue with respect to transportation and energy use, as low-cost or free parking tends to encourage automobile use and deemphasizes the use alternative transportation. In addition, surface

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[77] City of Burlington, Vermont, Department of Public Works, Department of Planning and Zoning, Community and Economic Development Office. Moving Forward Together: Transportation Plan for the City of Burlington. March 2011.

[78] TDMs aim to reduce congestion by promoting strategies to reduce single-occupancy vehicle trips, shift automobile traffic to non-peak periods, and/or reduce automobile trips altogether.

[79] City of Burlington, Vermont, Department of Public Works, Department of Planning and Zoning, Community and Economic Development Office. Moving Forward Together: Transportation Plan for the City of Burlington. March 2011.

[80] City of Burlington, Vermont, Department of Public Works, Department of Planning and Zoning, Community and Economic Development Office. Moving Forward Together: Transportation Plan for the City of Burlington. Technical Appendix. March 2011.

parking results in increases to stormwater runoff and nonpoint source pollution. Developing and maintaining downtown/waterfront parking is a consistent theme that runs through many of the policy and planning documents.

The Transportation Plan plainly states, "Parking in the downtown core is currently inadequate and action should be taken to address the issue."[81] The Technical Appendix to the Transportation Plan provides a well-constructed discussion about the City's ongoing debate regarding the appropriate amount of parking to successfully support the downtown/waterfront area.[82] Currently the CDO sets minimum off-street parking requirements for the downtown/waterfront area. Critics of minimum parking requirements contend that they:[83]

- Raise the costs of goods and housing;[84]
- Reduce the land available for development and increase urban sprawl;
- Have negative effects on the character of community;
- Subsidize the cost of operating an automobile;
- Reduce the viability of transit; and
- Results in unpleasant and dysfunctional design.

Business owners often contest these notions and express deep concern that a lack of parking will serve as a deterrent to people using the business district, particularly during the busiest times of year like the holidays. The City has recognized both sides of the debate by substantially reducing minimum parking requirements in the downtown/waterfront area in the latest update of the CDO. The CDO also implemented parking maximums. However, Burlington remains committed to a no net loss policy; therefore, any development occurring on existing parking will need to replace lost parking. The Technical Appendix also reflects on the challenges associated with this policy noting that many sites in the area simply cannot accommodate the replacement of lost parking spots.

The Technical Appendix details that the Steering Committee was unable to come to consensus on whether to keep the current system, strongly limit parking to lower demand, or shift to a market-based approach. It makes strong case for a market-based approach, advocating setting prices to ensure that utilization during peak periods reaches 85 percent.[85] IEc's research indicates that cities have been successful with this approach. For example, Redwood City, California uses demand-responsive meter rates that produce an average 18 percent availability rate in the downtown area. The average parking stay is 72 minutes. Before program implementation, these spaces were always occupied by day-long employees. Now, the program provides greater access for more shoppers and visitors.[86] Ultimately, the Transportation Plan

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[81] City of Burlington, Vermont, Department of Public Works, Department of Planning and Zoning, Community and Economic Development Office. Moving Forward Together: Transportation Plan for the City of Burlington. March 2011. Page 5.

[82] City of Burlington, Vermont, Department of Public Works, Department of Planning and Zoning, Community and Economic Development Office. Moving Forward Together: Transportation Plan for the City of Burlington. Technical Appendix. March 2011.

[83] For an excellent summary of the parking requirement debate, see Sherman, A. "The Effects of Residential Off-Street Parking Availability on Travel Behavior in San Francisco." San Jose State University Department of Urban and Regional Planning. May 2010. Available at: http://www.sjsu.edu/urbanplanning/docs/URBP298Docs/urbp298_HonorsReport_Sherman.pdf. This discussion is adapted from this paper.

[84] Developers and business pass the costs of parking construction and maintenance to homebuyers and consumers. This can lead to a decrease in affordable housing, as developers need to sell more expensive units to offset the cost parking requirements.

[85] City of Burlington, Vermont, Department of Public Works, Department of Planning and Zoning, Community and Economic Development Office. Moving Forward Together: Transportation Plan for the City of Burlington. Technical Appendix. March 2011.

[86] Seattle Department of Transportation. "Best Practices in Transportation Demand Management." Seattle Urban Mobility Plan. January 2008. Available at: http://www.seattle.gov/transportation/docs/ump/07%20SEATTLE%20Best%20Practices%20in%20Transportation%20Demand%20Management.pdf.

recommended a gradual approach that calls for a pilot pricing strategy in the downtown/waterfront area. The plan also calls for study of the expansion of parking a several areas.

As Burlington moves forward with its downtown/waterfront master plan, the City and participating public will need to carefully consider how to best utilize and manage its parking assets in the area, and how to identify the balance between parking and development. As part of this discussion, the City may wish to consider the effectiveness of the no net loss policy and its potential to impede development in the downtown/waterfront area. The Technical Appendix references payment-in-lieu or impact fees as potential alternatives to on-site parking. These strategies could fund more efficient parking in strategic locations throughout downtown/waterfront area.[87] For example, in Coconut Grove, Florida, businesses and residents have paid in-lieu of 938 downtown parking spaces, yielding $3 million in revenue. The funds helped construct a 416-space public parking garage with ground floor retail.[88]

Finally, as this City continues this debate, it could consider additional parking management measures, including:

- **Unbundling parking from real estate.** Selling parking spaces separately from the rent or sale of property provides incentive for homeowners to drive less or own fewer cars. It can also help reduce the cost of housing in the downtown/waterfront area.[89]
- **Increasing shared parking.** The City could consider promoting shared parking between businesses and residents. It may be possible for apartments and offices to share parking facilities, since the peak demand for the office occurs during the weekday, while the apartment peaks during evenings and weekends.[90]

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[87] City of Burlington, Vermont, Department of Public Works, Department of Planning and Zoning, Community and Economic Development Office. Moving Forward Together: Transportation Plan for the City of Burlington. Technical Appendix. March 2011.

[88] Seattle Department of Transportation. "Best Practices in Transportation Demand Management." Seattle Urban Mobility Plan. January 2008. Available at: http://www.seattle.gov/transportation/docs/ump/07%20SEATTLE%20Best%20Practices%20in%20Transportation%20Demand%20Management.pdf.

[89] Litman, T. "Parking Requirement Impacts on Housing Affordability." Victoria Transport Policy Institute. February 18, 2011. Available at: http://www.vtpi.org/park-hou.pdf.

[90] Litman, T. "Parking Requirement Impacts on Housing Affordability." Victoria Transport Policy Institute. February 18, 2011. Available at: http://www.vtpi.org/park-hou.pdf.

IEc

MEMORANDUM | September 30, 2011

TO Sandrine Thibault, Burlington Department of Zoning & Planning

FROM Dan Leistra-Jones and Angela Helman, Industrial Economics, Incorporated

SUBJECT Task 2: Compact Development, Travel Patterns, and Greenhouse Gas Emissions – Literature and Metrics

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INTRODUCTION

The City of Burlington, VT is currently in the process of developing a land use and development master plan for its downtown/waterfront area. The City envisions an aggressive plan that actively promotes climate-conscious development and transportation strategies. As a part of that process, identified as Task 2 of the Climate, Energy and Green Infrastructure Analysis, the City's Department of Planning & Zoning has contracted Industrial Economics, Inc. (IEc) to provide information helpful for assessing potential greenhouse gas emissions reductions that could be realized by promoting additional development in downtown Burlington, rather than at the suburban fringe.

This memorandum presents IEc's work under this Task. It discusses the key literature on the relationship between the built environment, vehicle miles traveled (VMT), energy use, and CO_2 emissions, and provides an information resource for communicating the benefits of shifting development away from outlying areas and toward the downtown/waterfront area. The memo also identifies relevant local data sources and metrics that can be used to track key environmental outcomes over time.

Our key findings are as follows:

- The literature suggests that denser development, on its own, will not have a significant impact on citywide VMT or CO_2 emissions, particularly for the relatively modest changes in density expected in Burlington over the next several years. Rather, other built environment factors appear to play a larger role in shaping travel behavior. If increased density is coupled with other aspects of compact development, such as a well-balanced mix of land uses, short distances from homes to key destinations, a pedestrian-friendly street network, and accessible transit, greater CO_2 savings could result.
- The literature indicates that on the *household level*, individuals or families choosing to live in a compact development rather than in a sprawling area are likely to have much lower VMT. Thus, increasing the housing available in the downtown/waterfront area would provide greater opportunities for residents to lessen household-level environmental impact and reduce transportation costs. Moreover, because the citywide VMT impacts of compact development may be modest, planners and others in Burlington may wish to focus on household-level savings when promoting the downtown/waterfront development plan.
- There does not appear to be sufficient data available for Burlington officials to directly measure environmental benefits *caused by* changes in the City's built environment. However, local-level

data are available that will enable officials to monitor whether changes in VMT, energy use, and CO_2 emissions are occurring *in tandem with* changes to the City's development patterns. These data will enable the City to ascertain whether its net environmental impact is growing or shrinking.

The memo is organized as follows. We begin by summarizing the literature on the relationship between the built environment and travel behavior, as measured by VMT. We discuss the relative importance of different built environment variables in influencing VMT; the link between public transportation, VMT, and CO_2; the methodological issue of selection bias; and the overall potential for compact development to reduce VMT on the city or household level. The next section details the relationship between VMT and CO_2. We then briefly explore the dynamics of compact development and residential energy use. We conclude by identifying local data sources and specific metrics that can be used to measure Burlington's environmental impacts as it relates to transportation and the built environment.

LITERATURE ON THE BUILT ENVIRONMENT AND VEHICLE MILES TRAVELED (VMT)

In this section, we explore how the built environment influences levels of driving, expressed as VMT. This is central to understanding the likely environmental impacts of Burlington's downtown/waterfront development plan.

Total VMT Reductions from Compact Development

Growing Cooler, a major work by highly regarded authors in the area of urban development and travel, and the Special Report on the same topic by the Transportation Research Board (TRB) take fairly similar approaches to estimate the overall reductions in VMT and CO_2 that could be expected over the next few decades due to more compact development. Each group of researchers makes assumptions in a number of areas, including:

- Key factors that drive estimates of carbon emissions;
- The rate at which existing buildings will be replaced;
- The share of future development that can be expected to be compact rather than sprawling;
- The reduction in household VMT per capita associated with less sprawling development; and
- The relationship between VMT and CO_2 emissions.

Researchers' assumptions diverge significantly, so that whereas Growing Cooler estimates that compact development could result in a 7 – 10 percent decrease in U.S. transportation-related CO_2 below business as usual, TRB's 'moderate' scenario predicts just a 1.3 – 1.7 percent decrease.[1] On a similar note, while Bartholomew (2007) found in a review of regional growth simulations that compact development scenarios reduced VMT by an average of just 2.3 percent compared to trend scenarios, a subsequent meta-analysis by Bartholomew and Ewing (2009) found an average reduction of 7.9 percent, with substantial variability between individual simulations.[2]

In a critique of the TRB report, Ewing, Nelson, and Bartholomew (co-authors and contributors to Growing Cooler) argue that TRB's approach is too conservative. The authors point to the fact that the TRB ignores commercial development entirely, assumes a building replacement rate for residences implying a 500-year building lifespan, and (in their view) fails to adequately address changes in housing

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[1] Ewing, Reid et al. Growing Cooler: The Evidence on Urban Development and Climate Change. Urban Land Institute, 2008 P. 35. See also National Research Council Transportation Research Board. "Special Report 298: Driving and the Built Environment: The Effects of Compact Development on Motorized Travel, Energy Use, and CO_2 Emissions." National Academy of Sciences, 2009. http://onlinepubs.trb.org/Onlinepubs/sr/sr298.pdf. P. 155.

[2] Bartholomew, Keith. "Land Use-Transportation Scenario Planning: Promise & Reality. Transportation 34. 2007. See also Bartholomew, Keith and Reid Ewing. "Land Use-Transportation Scenarios and Future Vehicle Travel and Land Consumption." Journal of the American Planning Association 75(1). Winter 2009. Cited in Moore et al. 2010, p. 569.

preferences that could come as the baby boomer generation enters retirement age.[3] It is worth noting, however, that even if these authors are correct, their own forecast of a 7 – 10 percent reduction below baseline CO_2 emissions is relatively small in comparison to the targets envisioned in most climate change policy discussions. This suggests that while a land use change can play a part in meeting climate change goals, it will not be sufficient on its own.

Key Built Environment Variables

There are several factors that distinguish compact development from sprawl. While early work focused largely on residential density, it soon became clear that residential density is an insufficient measure; on the basis of density, Los Angeles would be among the most compact cities in the nation, while Portland, Oregon would be sprawling. More recent work has suggested that density may be less important than other variables in influencing travel patterns. The literature often refers to the key built environment variables as the "four Ds:"

- Density, typically measured as people, jobs, or dwellings per unit area;
- Diversity, referring to the number of different land uses in an area and the degree to which they are balanced or mixed;
- Design, comprising street design elements such as street interconnectivity, block length, presence of sidewalks, etc.; and
- Destination accessibility, measured by the number of jobs or other key destinations (e.g., retail shops) reachable within a given travel time.[4]

A fifth D, distance to transit, is sometimes included as well; Ewing et al. note that "if we could think of an appropriate label, parking supply and cost might be characterized as a sixth D."[5] Nonetheless, most research to date has focused on the first four variables. The influence of these and other factors on travel behavior is often expressed in terms of 'elasticity,' that is, the proportional rate by which a change in an independent variable leads to a change in a dependent variable. Elasticity of -0.2, for example, would mean that a 100 percent increase in an independent variable (such as residential density) would result in a 20 percent decrease in the dependent variable (such as VMT), or that a 10 percent increase in one would lead to a 2 percent decrease in the other. A larger elasticity, whether positive or negative, means that a dependent variable is more responsive, whereas lower values connote a weaker link between the two.

Density and VMT

Density is probably the most studied dimension of land use, perhaps because it is easy to measure and communicate. However, the effects of higher densities on travel behavior are not necessarily straightforward; for example, shorter distances may encourage greater trip frequencies. Nonetheless, researchers agree that denser areas are generally associated with lower VMT.[6] One of the most well-known studies in this area was conducted by Holtzclaw et al. (2002). The researchers compared different neighborhoods in the San Francisco, Los Angeles, and Chicago metropolitan areas and found that auto ownership and use dropped systematically as residential density increased. Observers have critiqued this particular study, but the general pattern has held up in other research.[7]

Still, there is considerable disagreement as to the size of the density effect. The Victoria Policy Institute estimates that doubling urban densities can result in a 25 – 30 percent reduction in VMT, or slightly less

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[3] Ewing, Reid et al. "Response to Special Report 298 Driving and the Built Environment: The Effects of Compact Development on Motorized Travel, Energy Use, and CO2 Emissions." Metropolitan Research Center, University of Utah. September 16, 2009. http://www.smartgrowthamerica.org/documents/ResponsetoTRBSpecialReport.pdf

[4] Ewing, et al. 2008, p. 67.

[5] Ibid.

[6] National Research Council Transportation Research Board 2009, p. 51.

[7] Ibid, p. 55.

when controlling for other variables.[8] A Northeast-Midwest Institute working paper similarly states that "Most studies reviewed indicate that any doubling of density corresponds to lowering of VMTs by about 25 percent," i.e., an elasticity of -0.25.[9] In one of the largest such studies, Cervero and Murakami (2010) looked at 370 urban areas in the U.S. and found that VMT per capita had an elasticity of -0.381 with respect to density, with the direct effect of density being offset somewhat by the travel-inducing effects of denser roadway networks and greater access to destinations.[10]

Other researchers have found considerably smaller density impacts than those found in the above studies. Looking across the literature, the Transportation Research Board estimates that VMT has an elasticity of -0.05 to -0.12 with respect to density, or somewhat lower after separating out other land use factors.[11] In one of the early seminal works in the area, Ewing and Cervero (2001) look across multiple studies and derive an elasticity of -0.05 for both vehicle trips (VT) and VMT).[12] The same authors updated their meta-analysis in 2010 and found that in the literature, VMT had an average elasticity of -0.04 with respect to household and population density.[13] Walters and Ewing cite a similar range of -0.05 to -0.10.[14] These results imply that doubling residential density across an entire city would be expected to produce VMT per capita savings on the order of 5 – 10 percent. On a similar note, other studies have concluded that only at extreme levels does density have a substantial effect; a 2004 Department of Transportation study identified a threshold value of 6,000 – 7,000 people per square mile for density to have a meaningful impact on VMT per capita.[15] Other studies have not evaluated whether there may be a minimum threshold at which increased density has an impact. However, almost all research on the subject has taken place in urban areas more populous (and presumably denser) than Burlington. It is unclear what implications this may have for Burlington.

Other Built Environment Variables and VMT

Other land use factors appear to be more important than density in influencing VMT. Destination accessibility specifically appears to be quite influential. Destination accessibility can be measured in different ways, but in broad terms it refers to the number of jobs or other attractions reachable within a given travel time; this tends to be highest at central locations that have several key destinations in close proximity.[16] (Walk Score, available for public use at http://www.walkscore.com, provides an easy-to-understand destination accessibility measure.) Ewing et al. (2008) estimate that elasticities of VMT for diversity and design are approximately as strong as for density, but destination accessibility is much stronger at -0.20.[17] Walters and Ewing (2009) similarly estimate the elasticity of destination accessibility at -0.20 to -0.30.[18] In their updated meta-analysis, Ewing and Cervero (2010) find that the other 'D'

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[8] Walters, Jerry and Reid Ewing. "Measuring the Benefits of Compact Development on Vehicle Miles and Climate Change." Environmental Practice 11(3), September 2009. P. 203.

[9] Evans Paull. "Energy Benefits of Urban Infill, Brownfields, and Sustainable Urban Redevelopment: A Working Paper." Northeast-Midwest Institute, December 2008. http://www.nemw.org/images/stories/documents/energy_benefits_infill_brfds_final_12-08.pdf. P. 5.

[10] Cervero, Robert and Jin Murakami. "Effects of Built Environments on Vehicle Miles Traveled: Evidence from 370 US Urbanized Areas." Environment and Planning 42, 2010. P. 412-413, 415-416.

[11] National Research Council Transportation Research Board 2009, p. 4.

[12] Ewing, Reid and Robert Cervero. "Travel and the Built Environment." Transportation Research Record 1780, 2001. Cited in Ewing et al 2008, p. 70.

[13] Ewing, Reid and Robert Cervero. "Travel and the Built Environment: A Meta-Analysis." Journal of the American Planning Association 76(3), Summer 2010. P. 275.

[14] Walters and Ewing 2009, p. 205.

[15] Department of Transportation. "Emissions Benefits of Land Use Strategies." 2004. http://www.fhwa.dot.gov/environment/conformity/benefits. Cited in Moore, Adrian et al. "The Role of VMT Reduction in Meeting Climate Change Policy Goals." Transportation Research Part A 44, 2010. P. 570.

[16] Ewing et al. 2008, p. 68.

[17] Ewing, Reid and Robert Cervero. "Travel and the Built Environment." Transportation Research Record 1780, 2001. Cited in Ewing et al 2008, pp. 70-71.

[18] Walters and Ewing 2009, p. 205.

variables have stronger effects than density, with measures of destination accessibility being the most important. The table below presents their key results with respect to VMT; they found the same general pattern with respect to walking and transit use.[19,20]

EXHIBIT 1: ELASTICITIES OF VMT WITH RESPECT TO BUILT-ENVIRONMENT VARIABLES

		TOTAL NUMBER OF STUDIES	NUMBER OF STUDIES WITH CONTROLS FOR SELF-SELECTION	WEIGHTED AVERAGE ELASTICITY OF VMT
Density	Household/population density	9	1	-0.04
	Job Density	6	1	0.00
Diversity	Land use mix (entropy index)	10	0	-0.09
	Jobs-housing balance	4	0	-0.02
Design	Intersection/street density	6	0	-0.12
	% 4-way intersections	3	1	-0.12
Destination accessibility	Job accessibility by auto	5	0	-0.20
	Job accessibility by transit	3	0	-0.05
	Distance to downtown	3	1	-0.22
Distance to transit	Distance to nearest transit stop	6	1	-0.05

Source: Ewing and Cervero 2010, p. 275.

It is important to note that when considering the impacts of the 'four Ds' on VMT, the reported elasticities may be additive.[21] Thus, policy interventions that produce changes in more than one of these variables could result in stronger impacts than those policies that affect only one of the 'four Ds'. For the same reason, changes in multidimensional sprawl indexes (such as Smart Growth America's sprawl index) tend to show greater impacts than research that focuses on measuring the VMT impacts of single variables. It is for this reason that Growing Cooler, one of the most significant works in this area, can report on studies showing roughly 30 percent differences in VMT per capita between the most sprawling and least sprawling U.S. cities (as measured by multidimensional sprawl indexes), or state that doubling the first four 'D' variables can be expected to reduce VMT per capita by about one-third.[22] This may also explain why some studies found significantly greater elasticities of VMT with respect to density than others; not all authors controlled for the other built environment variables that contribute to VMT.

In short, while density is clearly associated with a reduction in VMT, other neighborhood characteristics are equally if not more important, and increased density in itself is not a cure-all. Municipalities seeking to decrease VMT and attendant CO_2 emissions should pay attention to the other 'D' variables, rather than focusing single-mindedly on density.

Public Transportation

One of the ways in which compact development is expected to reduce energy use and greenhouse gas emissions is by facilitating mode shifting, in which travelers walk, bike, or ride public transportation, and thereby reduce automobile trips. Yet changes in development patterns do not guarantee that residents will shift modes.

[19] Ewing and Cervero 2010, p. 275.

[20] Note that all of the works referenced in this paragraph are meta-analyses that themselves review several different individual studies.

[21] National Research Council Transportation Research Board 2009, p. 4.

[22] Ewing et al. 2008, pp. 6, 62, and 70-71.

The literature does not show that increased density, in and of itself, is associated with significantly greater levels of transit use. The meta-analysis by Ewing and Cervero (2010) found an average elasticity of transit use of just 0.07 with respect to residential density, and 0.01 for job density. The authors note that: "It is sometimes said that 'mass transit needs 'mass;' however, this is not supported by the low elasticities of transit use with respect to population and job densities" reported.[23] Of course, below some threshold of minimum density, there are simply not enough people to justify the existence of a transit route. However, factors other than density appear to drive decisions to use transit.

One such factor is greater access, defined as distance to transit. The literature is mixed on the extent to which greater access to transit can itself induce higher levels of ridership. The Transportation Research Board indicates that "a 10 percent increase in rail and bus route miles lowers the probability of driving by only 0.03 percent when New York, which is an outlier in terms of the amount of transit service, is excluded."[24] However, Ewing and Cervero (2010) find a much stronger effect for distance to transit stops, with an elasticity of -0.29 for transit usage.[25] This means that doubling the distance from the average home to the nearest transit stop is associated with a 29 percent drop in transit ridership.

Furthermore, while walking or biking will result in direct CO_2 emissions reductions, public transit has its own emissions that dampen savings realized by reduced automobile use. Ridership per vehicle is the key determinant in energy and emissions savings provided by public transit options. Moore et al. (2010) provide a critique based on the Department of Energy's Transportation Energy Data Book, which we update here with more recent data.[26] The average car in the U.S. uses 5,465 Btu per vehicle-mile, while the average transit bus uses 39,906. Thus, a bus would need to carry an average of 11.7 passengers at all times in order to be as efficient as a group of cars (assuming an average of 1.6 passengers per car).[27,28] Of course, if routes and schedules are already established, any passenger that chooses to use public transit rather than drive will reduce overall CO_2 emissions. Yet from a planning perspective, officials should be aware that a transit system (or an individual route) with relatively few passengers could actually increase greenhouse gas emissions.

Finally, it appears that selection bias may play a major role in determining varying levels of transit usage in different neighborhoods. That is to say, people who are very interested in using public transit may choose to live close to a bus or train stop. This is discussed in greater detail below.

Selection Bias

One of the key issues in research on travel and the built environment is the extent to which different neighborhood characteristics actually induce different travel behaviors, rather than such behavioral differences simply reflecting the pre-existing preferences of the residents who live there. In this context, *selection bias* means that studies that show less driving by residents of central urban areas may simply indicate that people who prefer not to drive choose to live in central areas, exhibiting what is known as self-selecting behavior. To the extent that reported results are driven by uncontrolled selection bias, in which this self-selection of living in a central area is not accounted for, studies will overstate the degree to which changes in the built environment will actually lead to changes in travel behavior.[29] Thus,

[23] Ewing and Cervero 2010, pp. 275-276.

[24] National Research Council Transportation Research Board 2009, p. 73.

[25] Ewing and Cervero 2010, p. 275.

[26] Moore et al. 2010, p. 571.

[27] I.e., 39,906 Btu per vehicle-mile / (5,465 Btu per vehicle-mile / 1.6 passengers) = 11.7 passengers.

[28] Department of Energy Center for Transportation Analysis. "Transportation Energy Data Book." Edition 29, June 30, 2010. Table 2-12. http://cta.ornl.gov/data/index.shtml

[29] Xinyu Cao. "Exploring Causal Effects of Neighborhood Type on Walking Behavior Using Stratification on the Propensity Score." Environment and Planning A (42), 2010. P. 488.

understanding the degree to which selection bias exists is important to accurately predict the impacts of proposed changes in the built environment.[30]

The literature differs on the importance of self-selection in the observed correlation between built environment characteristics and travel behavior.[31] The Transportation Research Board (2009) identifies five comprehensive reviews of this literature and finds that "The majority of the studies reviewed find a statistically significant effect of the built environment after controlling for socioeconomic characteristics and self-selection. However, the survey authors characterize these results as 'mixed.'"[32] A later review by Cao et al. (2010) examined 38 studies and found that while many found evidence of self-selection, after controlling for this effect, virtually all of them still found that the built environment has a significant influence on travel behavior.[33]

Compared to the large number of papers exploring the built environment and travel behavior, relatively few studies have attempted to quantify the relative influence of self-selection versus environmental factors. Note, for example, that few of the studies examined by Ewing and Cervero (2010) and included above in Exhibit 1 controlled for self-selection. Ewing and Cervero do identify several other studies that control for selection bias, however. These works found that anywhere from 48 – 98 percent of differences in VMT and walking was due to environmental influences, with the balance due to self-selection.[34] A paper by Cao (2010) is especially noteworthy for its methodological approach, which uses propensity score stratification, a statistical technique ideally suited for controlling selection bias, to examine walking behavior in eight neighborhoods in northern California. Cao found that neighborhood type accounted for 61 percent of observed differences for destination-based walking and 86 percent for recreational walking.[35] Mathematically, this implies that if self-selection is not controlled for, the impact of the built environment would be overstated by 64 percent for destination-based walking and 16 percent for recreational walking.[36]

Some researchers have noted that the phenomenon of self-selection could *in itself* produce some changes in travel behavior if more compact developments are built. This would be the case if there is currently an unmet demand for pedestrian-oriented neighborhoods, which forces people to live in neighborhoods where they drive more than they ideally want to.[37] By providing opportunities for such residents to live in areas that satisfy their preferences, compact development could reduce VMT even if the effect was driven by self-selection rather than environmental factors as such.[38]

Overall, it is clear that both self-selection and environmental influences contribute to observed differences in travel behavior among residences of various neighborhood types. Although environmental factors appear to dominate, the literature suggests that where selection bias is not controlled for, the predicted impacts of compact development on travel behavior may be somewhat overstated. However, even where self-selection is important, areas that have unmet demand for pedestrian-oriented neighborhoods could achieve VMT reductions by creating compact neighborhoods that allow residents to choose housing that better reflects their preferences. Thus, Burlington's Transportation Plan notes, correctly, that "Transit

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[30] National Research Council Transportation Research Board 2009, p. 58.

[31] Ibid, p. 60.

[32] Ibid, p. 66. The studies identified by the Transportation Research Board include Badoe and Miller 2000; Crane 2000; Ewing and Cervero 2001; Handy 2005; and Cao et al. 2008. See Transportation Research Board 2009 for complete citations.

[33] Cao 2010, p. 488.

[34] Ewing and Cervero 2010, pp. 266-267. The studies identified by Ewing and Cervero include Salon 2006; Zhou and Kockelman 2008; Cao 2010 (discussed in this report); Cao, Xu and Fan 2009; and Bhat and Eluru 2009. See Ewing and Cervero for complete citations.

[35] Cao 2010, p. 500.

[36] I.e., 1/0.61 – 1 =0 .64; 1/0.86 – 1 = 0.16. See Cao 2010, p. 502.

[37] Cao 2010, p. 487.

[38] Walters and Ewing 2009, p. 203.

services should be provided where higher-density, mixed-use development is anticipated well in advance, rather than re-routed in response to new development proposals after that fact."[39]

Household-level VMT Reductions from Compact Development

While the literature is mixed on the extent to which more compact development would lead to aggregate citywide reductions in VMT, researchers appear more unified in their assessment of the impacts for individual households choosing to live in a compact, centrally located neighborhood. Households living in more compact developments tend to have lower VMT for multiple reasons: shorter driving distances to work and other key destinations; the presence of public transportation networks as a viable alternative to driving; and the option to walk or bike instead of drive, due to the shorter distances involved.

The Canada Mortgage and Housing Corporation developed a statistical model of greenhouse gas emissions quantifying the empirical relationships between neighborhood characteristics, housing design, and locational factors on VMT and CO_2. The agency then applied the model to generic neighborhood types in the Toronto area. They found that households moving from an outer suburb to a central area would reduce their VMT by an average of 42 – 60 percent, depending on the particular neighborhood types involved. Households moving from an inner suburb to a central area would reduce their VMT by 20 – 35 percent.[40] Evans Paull, a prominent researcher in the field of urban redevelopment, equates the effect of an individual moving from the suburbs to an urban compact development to driving a hybrid vehicle, saving about two tons of CO_2 per year.[41]

Looking more broadly, Ewing et al. (2008) survey the range of primary research and identify 10 studies considering the effects of regional location of individual developments on travel and emissions. Overall, these studies show that "infill locations generate substantially lower VMT per capita than do greenfield locations, from 13 to 72 percent lower."[42] On the basis of this and other literature, Ewing et al. conclude that when comparing individual developments, compact development options will reduce the need to drive between 20 and 40 percent, as compared with development at the outer suburban edge with isolated homes, workplaces, and other destinations. Thus, one could assume a 30 percent reduction in VMT when comparing individual compact developments to homes built at the suburban edge.[43] As detailed below, this would translate into a 28 – 30 percent reduction in automobile-related energy use and CO_2 emissions for affected households. We discuss this link in the following section.

VEHICLE MILES TRAVELED AND CARBON DIOXIDE

All else being equal, every mile driven in an automobile result in a proportional increase in fuel consumption and greenhouse gas emissions. Thus, in proportional terms, any reductions in VMT caused by compact development should produce an identical reduction in automobile CO_2 emissions. However, shorter average trip lengths and lower vehicle speeds and CO_2 emissions may not fall by quite the same amount as VMT as a result of compact development.

A number of researchers simply assume a direct one-to-one correspondence between VMT and automobile CO_2 emissions. The TRB's major work, "Driving and the Built Environment: The Effects of Compact Development on Motorized Travel, Energy Use, and CO_2 emissions," uses this approach. So too

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[39] City of Burlington Department of Public Works, Department of Planning and Zoning, and Community Economic Development Office. "Moving Forward Together: Transportation Plan for the City of Burlington." Adopted March 28, 2011, p. 15. http://www.ci.burlington.vt.us/docs/4593.pdf

[40] Walters and Ewing 2009, pp. 200-201.

[41] Paull 2008.

[42] Ewing et al. 2008, p. 88. The studies identified include EPA 1999, 2001, and 2006; Hagler Bailly, Inc. 1998; Hagler Bailly, Inc. and Criterion Planners/Engineers 1999; IBI Group, Canada Mortgage, and Natural Resources Canada 2000; Allen and Benfield 2003; U.S. Conference of Mayors 2001; and SACOG 2007. See Ewing et al. 2008 for complete citations.

[43] Ewing et al. 2008, p. 9.

does Andrews 2008, which develops a framework for estimating greenhouse gas emissions from different types of development.[44] Using this method, VMT is typically translated into gasoline use using an average factor for fleet-wide automobile fuel economy. The Bureau of Transportation Statistics tracks and reports this number on a quarterly basis; as of 2008, the most recent year for which data was available, the average passenger car in the U.S. got 22.6 miles per gallon (mpg) and the average light truck got 18.1.[45] Because passenger cars accounted for 59 percent of miles driven,[46] this equates to an overall fuel efficiency of about 20.8 mpg, or inversely, 0.048 gallons per mile. This must be converted into CO_2; EPA uses a value of 19.4 lb. CO_2 per gallon gasoline (22.2 for diesel).[47] Thus, every mile driven in an automobile emits an average of 0.0481 x 19.4 = 0.93 lb. CO_2.

Yet development patterns not only influence the total number of miles driven; they also impact the duration and speed of those trips. When destinations are closer and more accessible, as would be expected in a compact development, trip lengths will be shorter. Because vehicles use more fuel and emit more CO_2 on starting up than in the course of driving, this means that drivers whose travel consists of shorter trips will use slightly more fuel per mile on average than drivers of longer trips. The California Air Resources Board estimates typical 'cold start' emissions at 213 grams CO_2 (0.47 lb., equivalent to about a half-mile of driving).[48]

Greater population and employment density would also be expected to lead to greater congestion, as more vehicles pack onto the roads. This will in turn lead to lower vehicle speeds and, again, greater CO_2 emissions per mile. Ewing et al. (2008) estimate that in a typical urban area, a 50 percent increase in density would lead to a 7.5 percent decrease in peak-hour driving speed; this in turn would cause a two percent increase in CO_2 per mile.[49] Taking into account penalties from both lower peak speeds and cold starts, they arrive at a VMT-CO_2 ratio of 0.93. That is, they project that a one percent reduction in VMT due to compact development translates into a 0.93 percent reduction in CO_2 from automobiles.[50]

Burlington appears to have relatively little traffic compared to the larger urban areas that are the focus of most travel-built environment research. For instance, the average commute time for workers in the Burlington-South Burlington metropolitan area is 18.8 minutes. By contrast, the Manchester-Nashua metropolitan area, in New Hampshire, has a mean commute time of 25.6 minutes, and the mean commute time in Boston is 28.5 minutes.[51] For this reason, changes in Burlington's development patterns – especially on the relatively modest scale likely to occur – may not add enough cars to result in an appreciable decrease in vehicle speeds. If this is the case, then the observed VMT-CO_2 ratio would be closer to 1.0. Thus, for Burlington, we recommend considering a VMT-CO_2 ratio of 0.93 as the lower bound, with an upper bound of 1.0.

RESIDENTIAL ENERGY USE

The literature on development patterns and energy focuses primarily on transportation choices. However, development modes also impact residential building energy use. This is mainly because compact

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[44] Clinton J. Andrews. "Greenhouse Gas Emissions Along the Rural-Urban Gradient." Journal of Environmental Planning and Management 51(6). November 2008, pp. 847-870.

[45] Department of Transportation Bureau of Transportation Statistics. "National Transportation Statistics Table 4-23: Average Fuel Efficiency of U.S. Passenger Cars and Light Trucks." January 2011. http://www.bts.gov/publications/national_transportation_statistics/

[46] Department of Transportation Bureau of Transportation Statistics. "National Transportation Statistics Table 1-35: U.S. Vehicle-Miles." July 2010. http://www.bts.gov/publications/national_transportation_statistics/

[47] Environmental Protection Agency. "Emission Facts: Average Carbon Dioxide Emissions Resulting from Gasoline and Diesel Fuel." EPA420-F-05-001. February 2005. http://www.epa.gov/otaq/climate/420f05001.htm#carbon

[48] Data based on EMFAC 2007, v2.3, provided by Jeff Long, California Air Resources Board. Cited in Ewing et al. 2008, p. 45.

[49] Ewing et al. 2008, p. 47.

[50] Ibid, p. 34.

[51] Data from U.S. Census Bureau, 2005-2009 American Community Survey. Table SO801: Commuting Characteristics by Sex. http://factfinder.census.gov/servlet/DatasetMainPageServlet?_lang=en&_ts=329045287912&_ds_name=ACS_2009_5YR_G00_&_program=

development tends to promote multi-family buildings and smaller single-family homes rather than larger, detached single-family dwellings. Such buildings have lower volumes and outside surface area per person, resulting in lower heating and cooling loads.

Looking at average levels of consumption, some studies have found that residents in multi-family units consume nearly 50 percent less electricity and total energy than single-family homes. However, because these studies do not account for income or other demographic characteristics, these results are not necessarily transferable to all situations. Keeping income and dwelling size constant and evaluating only the physical impacts of reduced surface area, researchers have estimated multifamily dwellings to use 20 percent less energy per person than single-family detached homes.[52,53] Kockelman et al. (2009), meanwhile, estimated that a family moving from a 2,400 sq. ft. detached single-family home (the U.S. average in 2007) to a modestly smaller 2,000 sq. ft. apartment would save an average of 37 percent of total energy use. Downsizing to a 2,000 sq. ft. detached single-family home would produce only modest savings of about 4.4 percent of total energy use.[54]

Interacting with this effect, compact development also affects residential energy use through location, via the heat island effect. Due to the thermal properties of most building materials, urban areas often experience warmer ambient temperatures than nearby rural areas. The annual average air temperature in a large city can be 1-3°C warmer than the surrounding area.[55] Shifting a greater proportion of development to urbanized areas will therefore expose residents to slightly warmer temperatures.

Ewing and Rong (2008) find that each 10 percent increase in a city's compactness (using a multi-attribute index) decreases heating degree-days by two percent and increases cooling degree-days by 4.7 percent.[56,57] In Burlington, which has a relatively cold climate, the heat island effect could actually result in a net decrease in energy use. The city has 7,710 heating degree days annually but just 462 cooling degree days,[58] so these percentage changes would translate into a decrease of 154 heating degree days and an increase of 22 cooling degree days. Energy savings from milder winters would therefore outweigh increased consumption during hotter summers. In practice, Burlington's heat island effect is likely small enough that the overall impact would be minimal.

Finally, observers have noted that more compact and centrally located development should lead to lower losses on electric transmission lines. Given the small distances involved, however, the effect is likely to be quite small, and it appears researchers have not attempted to quantify it.[59]

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[52] Naomi Freeman. "Connecting Energy and Smart Growth." Environmental and Energy Study Institute presentation, 2006. See also Viera, Robin and Danny Parker. "Energy Use in Attached and Detached Residential Developments: Survey Result." Florida Solar Energy Center, 2007. http://www.fsec.ucf.edu/en/publications/html/FSEC-cr-381-91/ Cited in Paull 2008, p. 7.

[53] Paull 2008, p. 12.

[54] Kockelman, K. et al. "GHG Emissions Control Options: Opportunities for Conservation." University of Texas, Austin, 2009. http://onlinpubs.trb.org/Onlinepubs/sr/sr298kockelman.pdf. Cited in Transportation Research Board 2009, pp. 175, 199.

[55] Environmental Protection Agency. "Heat Island Effect." June 17, 2011. http://www.epa.gov/heatisland/

[56] Ewing, Reid and Fang Rong, "The Impact of Urban Form on US Residential Energy Use." Housing Policy Debate 19 (1), 2008. Cited in Ewing et al. 2008, p. 111.

[57]Heating degree-days measure the number of degrees that a day's average temperature is below 65º Fahrenheit. For example, if the average temperature for a day is 50ºF, it would have 15 degree-days. Similarly, cooling degree-days measure the number of degrees that a day's average temperature is above 65ºF. Aggregating heating degree-days and cooling degree-days over an entire year provides a useful indicator for the total amount of energy needed to heat and cool buildings to maintain comfortable temperatures.

[58] National Oceanic and Atmospheric Administration National Weather Service. "Burlington, VT Monthly Totals/Averages HDD (base) 65," and "Burlington, VT Monthly Totals/Averages CDD (base) 65." http://www.erh.noaa.gov/btv/climo/BTV/monthly_totals/hdd.shtml and http://www.erh.noaa.gov/btv/climo/BTV/monthly_totals/cdd.shtml

[59] Andrews 2008, p. 459.

Overall, households living in compact developments can generally expect to use less energy than those living in sprawling areas; the heat island effect could amplify this impact. Translating residential energy use to CO_2 emissions is a straightforward undertaking, requiring only some additional information on the electricity generation fuel mix. This will be discussed along with other Burlington-specific data in the following section.

LOCAL-LEVEL DATA AND METRICS FOR BURLINGTON

The previous sections of this memo have discussed literature on the relationship between denser development (defined in various ways), VMT, and energy and CO_2. These sections are designed to illustrate the general state of understanding regarding these issues. In this section, we pull out the key points from the previous sections and apply them to the specific local context of Burlington. Our goals are twofold: first, to provide adjustment factors as needed for the numbers presented above; and second, to highlight the data sources and metrics available to local Burlington officials to use in tracking development-related energy and CO_2 impacts over time.

We note that Burlington's recently adopted Transportation Plan includes several progress indicators intended to track the City's performance over time. Some of these indicators could be particularly relevant for estimating energy and greenhouse gas impacts, including:

- Transit ridership (annual);
- Traffic volumes into and out of the City (vehicles per weekday);
- Transportation Management Association (TMA) Employee Mode Shares (percent walking biking, using transit, carpooling); and
- Energy Use/Greenhouse Gas Emissions (estimated fuel consumption in City, and by City residents by cars, trucks and buses).[60]

The Transportation Plan does not provide details on how this information will be collected.

Vehicle Miles Traveled

Theoretically, changes in the 'D' built environment variables (density, diversity, design, destination accessibility, and distance to transit) in the Burlington area should result in changes in VMT on the levels shown in Exhibit 1 above;[61] uncontrolled selection bias in the underlying studies may mean the observed effect will be somewhat smaller. There are a wide variety of ways in which these variables can be defined.[62] However, it appears that there are no data available tracking VMT on a sufficiently fine-grained scale for Burlington officials to compare residents and/or workers in the downtown/waterfront area to those who live and work farther away. Nor do there appear to be available data on the 'D' variables measured on a scale consistent with locally available VMT data. Consequently, officials will not be able to directly measure the impact of more compact development on VMT, unless Burlington undertakes new data collection efforts. Data collection efforts to track differences in VMT of residents in different areas of Burlington, or to track other 'D' variables, would likely be resource intensive undertakings, and would require public cooperation with new survey efforts. For these reasons, we do not recommend specific measures of the 'D' variables to track over time.

However, officials can examine data on travel patterns from the Bureau of Transportation Statistic's National Household Travel Survey (NHTS), the Census Bureau's annual American Community Survey, and local surveys of employee travel patterns by the Campus Area Transportation Management

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[60] City of Burlington Department of Public Works, Department of Planning and Zoning, and Community Economic Development Office 2011, p. 11.

[61] Ewing and Cervero 2010, p. 275. Note that this and other studies in this area evaluated urban areas much more populous in Burlington. It is unclear whether, due to Burlington's smaller size, the effects realized in Burlington from changes in development patterns may be greater or lesser than those noted in the general literature.

[62] See, e.g., Ewing and Cervero 2010, p. 267, and Ewing et al. 2008, pp. 67-68.

Association (CATMA). This approach should enable City officials to monitor the extent to which residents' travel behavior is changing over time as the cityscape changes.

The NHTS could prove to be a particularly rich data source, but it is updated relatively infrequently.[63] While the main body of the NHTS only reports nationwide data, states and metropolitan planning organizations (MPOs) can arrange for additional samples to be taken on a smaller geographic scale when the survey is being conducted. In 2009, the Chittenden County MPO and the Vermont Agency of Transportation partnered to purchase an additional sample of 1,690 households, of which 541 were in Chittenden County and the remainder elsewhere in the state.[64] Assuming that these organizations continue to purchase add-on samples in the future, area officials could have a substantial array of data available to track travel patterns over time.

While complete summary data from the Vermont NHTS sample were not readily available, a number of key statistics are reported in the 2010 Vermont Transportation Energy Report. Most importantly, this document reports VMT per capita at the county level; the figure for Chittenden County was approximately 9,500 VMT per person in 2009. Recall that Ewing et al. (2008) estimated that individuals could reduce their VMT by 20 – 40 percent by living in a compact development;[65] for Burlington residents, this would suggest a reduction of 1,900 – 3,800 VMT per person per year that moves from sprawling areas into compact developments.

The Vermont report also provides figures for average commute distance (9.1 miles for Chittenden County) and mode of travel to work (94 percent in automobiles, less than 1 percent by bus statewide; data not reported on a county level).[66] Based on the nationwide NHTS, it appears that survey data is also being collected for several other factors not listed in the Vermont Transportation Energy Report, including annual vehicle trips per person and per household, average trip length, and commute trip time, distance, and speed (reported separately for automobiles, transit, and walking).[67]

It will be several years before the next NHTS update is carried out. In the interim, Burlington officials may want to examine data from the Census Bureau's American Community Survey (ACS), which reports data on residents' means of transportation to work, place of work (i.e., in the county/state of respondents' residence), and average commute time. Note, however, that while means of transportation to work in particular could be quite useful, there is no clear way to translate travel time into travel distance without additional information. The ACS does not report on distance traveled to work or distances traveled for non-work purposes. Another potential data source consists of surveys conducted by local-level organizations. The existing Campus Area Transportation Management Association (CATMA) conducts surveys on its' employees commuting habits; a Downtown Transportation Management Association (DTMA) could presumably gather similar data for downtown workers.[68]

To measure environmental benefits associated with changes in Burlington's development patterns, officials should rely on direct survey measures of VMT, i.e., from subsequent updates to the NHTS (and from TMA surveys, to the extent they measure VMT or home-to-work distance). In percentage terms, officials can use the range of values noted previously in this memo to translate VMT into CO_2 emissions, namely, a 0.93 – 1 percent drop in CO_2 for every 1 percent decrease in VMT. In absolute terms, the

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[63] Prior to the 2009 NHTS, the four previous surveys were conducted in 2001, 1995, 1990, and 1983.

[64] University of Vermont Transportation Research Center. "NHTS (National Household Travel Survey) Vermont. 2011. http://www.uvm.edu/~transctr/?Page=nhts_default.php&SM=_researchmenu.html

[65] Ewing et al. 2008, p. 9.

[66] University of Vermont Transportation Research Center. "The Vermont Transportation Energy Report: Vermont Clean Cities Coalition." TRC Report # 10-0017. August 2010, pp. 13-15. http://www.uvm.edu/~transctr/cleancty/pdf/UVM-TRC-10-017.pdf

[67] Department of Transportation Federal Highway Administration. "Summary of Travel Trends: 2009 National Household Travel Survey." FHSA-PL-11-022. June 2011. http://www.uvm.edu/~transctr/cleancty/pdf/UVM-TRC-10-017.pdf

[68] City of Burlington Department of Public Works, Department of Planning and Zoning, and Community Economic Development Office, 2011

average passenger vehicle gets 20.8 miles per gallon (i.e., it uses 1 / 20.8 = 0.048 gallons per mile) and emits 19.4 lb. CO_2 per gallon gasoline; this translates into average emissions of 0.93 lb. CO_2 per mile.[69] Thus, every one VMT decreased should result in a net decrease of 0.86 – 0.93 lb. CO_2.

Data on commute modes alone (i.e., ACS data) will not be sufficient to estimate VMT. However, the environmental benefits of shifts from automobile to public transportation use, which can be observed in ACS data, can be estimated in the manner described below.

Public Transportation

The Chittenden County Metropolitan Planning Organization's Long Range Regional Transportation Plan calls for a tenfold increase in use of public transportation over a 20-year span, from 0.6 to 6 percent of all trips taken. Chittenden County estimated that 2.4 percent of all trips would be taken by transit in 2010.[70] Clearly, there is an expectation that transit could play a significant role in Burlington's transportation future. If this is realized, there are multiple ways in which Burlington could estimate environmental benefits from public transportation.

The Chittenden County Transportation Authority (CCTA), which runs the bus system in the Burlington area, reported a total of 2,455,730 riders in its fiscal year 2010. This number has been trending generally upward in recent years, albeit with a slight decrease from 2009 – 2010. All CCTA buses use diesel fuel and average between 3.5 and 6 miles per gallon (mpg).[71] The overall fleet averages about 4.27 mpg.[72]

The CCTA also tracks the total number of miles driven and the total quantity of fuel used by all of its buses (1,589,359 miles and 372,534 gallons in FY 2011).[73] It is unclear whether the CCTA gathers data on the distances traveled by individual passengers; at least an estimate of distances would be necessary to calculate the agency's total passenger-miles (a key parameter in estimating relative environmental impacts). As described above, comparing CCTA's fuel used per passenger-mile (i.e., total fuel use divided by total passenger-miles) to results using typical passenger vehicles reveals the net environmental benefit per person from the CCTA transit system. Since the 'average' car carries 1.6 people at any given time, the nationwide average of 20.8 mpg would translate into 1 / (20.8 x 1.6) = 0.03 gallons per person-mile for passenger vehicles. The fuel used per passenger-mile by CCTA buses should be subtracted from this figure to produce a net reduction per person-mile. As noted above, the 'average' bus would need to carry about 11.7 people at all times to produce an efficiency gain.[74] To translate levels of fuel use into CO_2 emissions, we must apply fuel emissions factors. As reported earlier, EPA estimates CO_2 emissions from gasoline at 8,788 grams (19.4 lb.) per gallon, and 10,084 grams (22.2 lb.) per gallon for diesel fuel.[75]

Burlington could calculate environmental gains from public transportation as shown in Exhibit 2.

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[69] Moore et al. 2010, p. 571, and Department of Energy Center for Transportation Analysis 2010.

[70] City of Burlington, Vermont. "2006 Municipal Development Plan." Adopted May 22, 2006. http://www.ci.burlington.vt.us/planning/comp_plan/municipal_development_plan/2006/mdp_2006_complete_burlington_vermont.pdf

[71] Data provided by Jon Moore, Chittenden County Transportation Authority. Personal correspondence with Sandrine Thibault, Department of Planning & Zoning, City of Burlington. July 6, 2011.

[72] Data provided by Jon Moore, Chittenden County Transportation Authority. Personal correspondence with Sandrine Thibault, Department of Planning & Zoning, City of Burlington. July 19, 2011.

[73] Ibid.

[74] Moore et al. 2010, p. 571, and Department of Energy Center for Transportation Analysis 2010.

[75] Environmental Protection Agency, 2005.

EXHIBIT 2: CALCULATING ENVIRONMENTAL GAINS FROM PUBLIC TRANSPORTATION

ROW	CALCULATION STEP	CURRENT VALUE	DATA SOURCE
[1]	Total Bus Gallons (Diesel) Consumed	372,534	CCTA
[2]	/ Total Bus Passenger-Miles	Unknown	CCTA
[3]	= Bus Gallons (Diesel) per Person-Mile	[1] / [2]	Calculated
[4]	x CO_2 per Gallon (Diesel)	22.2 lb.	EPA
[5]	= Bus CO_2 per Person-Mile	[3] x [4]	Calculated
[6]	Automobile Gallons (Gasoline) per Person-Mile	0.03	U.S. Average
[7]	x CO_2 per Gallon (Gasoline)	19.4 lb.	EPA
[8]	= Automobile CO_2 per Person-Mile	[6] x [7] = 0.582 lb.	Calculated
[9]	Net CO_2 Reduction per Passenger-Mile from Riding Bus	[8] – [5]	Calculated
[10]	Total CO_2 Reduction from Riding Bus	[9] x [2]	Calculated

Note that performing the above exercise for each bus route individually, rather than for the system as a whole, would facilitate an analysis of specific routes that net the most energy savings.

Building Energy Use

Burlington's electricity is provided by the Burlington Electric Department, a public utility. The utility also owns much of the electricity generation used to provide power to the town. It appears that the utility does not routinely track electricity consumption for the downtown/waterfront area separately from the rest of its service area; thus, it will most likely not be feasible to directly measure changes in consumption due to denser development. However, the utility does track average consumption by rate class. At present, area residential consumers use an average of 5,190 kWh of electricity annually, while commercial customers use an average of 51,806 kWh. [76]

A number of residences and businesses in Burlington rely on natural gas for heating and other purposes. As with the Electric Department, the local gas utility, Vermont Gas, does not track average use on a neighborhood scale. Vermont Gas reports average residential consumption of 900 ccf of gas per year; commercial use varies widely depending on the type of establishment, so that overall averages are not as meaningful.[77]

Other homes rely on oil; 1.7 million homes across New England (excluding Massachusetts) used fuel oil for space heating in 2009, roughly twice as many as used natural gas.[78] However, fuel oil data is not collected at the local level, so we cannot readily estimate or track levels of consumption in Burlington.

While it would be difficult to establish a clear causal link between Burlington's land use policies and building energy use, we recommend that City officials continue to track these average consumption figures to determine whether any observed changes in developmental density that occur over the next several years are correlated with lower consumption. Applying the generic findings noted above, Burlington residents that move from a typical detached single-family home to a smaller detached home would save on the order of 4.4 percent of their total electricity and natural gas use; moving to an apartment could expect to save 20 – 37 percent. Using Burlington's levels of consumption, this would translate to savings 228 kWh electricity and 40 ccf natural gas for a smaller detached home (worth about $92 at current retail rates), or 1,038 – 1,920 kWh electricity and 180 – 333 ccf gas for an apartment

[76] Burns, Chris. Burlington Electric Department. Personal correspondence with Sandrine Thibault, Department of Planning & Zoning, City of Burlington. June 28, 2011.

[77] Harrington, Scott. Vermont Gas. Personal correspondence with Shelly Martin, Spring Hill Solutions. June 29, 2011.

[78] Department of Energy, Energy Information Administration. "Residential Energy Consumption Survey, Table HC1.8: Fuels Used and End Uses in Homes in Northeast Region, Divisions, and States, 2009." 2011. http://www.eia.gov/consumption/residential/data/2009/#fueluses

(worth about \$414 – \$766).[79] Because Burlington has more heating degree days than cooling degree days, the savings realized may be slightly greater if the heat island effect is of sufficient magnitude.

Calculating CO_2 savings from reductions in natural gas use is straightforward; burning one ccf natural gas emits about 12 lb. of CO_2.[80] To calculate the carbon impact of electricity use, we must evaluate the mix of fuels used to generate electricity in the area. According to EPA's eGRID database, Vermont averaged just 0.00342 lb. CO_2 per kWh electricity generated in 2007, by far the lowest rate in the nation; this was due to the state's near-total reliance on nuclear, hydro, and biomass for electricity generation.[81] However, the Burlington Electric Department reports a considerably less favorable emissions profile after adjusting for short-term electricity purchases and sales of Renewable Energy Certificates, in which the unbundled electricity is assigned the characteristics of the New England residual fuel mix. Accounting for these factors, the utility's fuel mix in 2010 was 24.35 percent natural gas, 6.63 percent coal, 4.22 percent oil, and the remainder nuclear and renewables.[82] Using average emissions rates from EPA,[83] this would mean that Burlington consumers are actually emitting 0.497 lb. CO_2 per kWh electricity.[84]

Summary of Local Data and Metrics for Burlington

In summary, we recommend that Burlington officials use the following estimates and metrics to communicate the prospective climate-related benefits of compact development, and to measure the city's performance over time.

[79] See https://www.burlingtonelectric.com/page.php?pid=11&name=residential_rates and http://www.vermontgas.com/residential/res_rates.html

[80] Environmental Protection Agency. "Compilation of Air Pollutant Emission Factors. Volume I: Stationary Point and Area Sources." AP-42, Supplement D: Chapter 1.4, July 1998. P. 1.4-6. http://www.epa.gov/ttn/chief/ap42/ch01/final/c01s04.pdf

[81] Environmental Protection Agency. eGRID2010 database Version 1.1. May 20, 2011. http://www.epa.gov/cleanenergy/energy-resources/egrid/index.html

[82] Burlington Electric Department. "Power Supply: BED's Power Supply for 2010." July 14, 2011. https://www.burlingtonelectric.com/page.php?pid=128&name=BED%27s%20Power%20Supply

[83] Environmental Protection Agency. "Clean Energy: Air Emissions." December 28, 2007. http://www.epa.gov/cleanenergy/energy-and-you/affect/air-emissions.html

[84] EPA's emissions factors are 1.14 lb. CO_2 per kWh natural gas, 2.25 lb. per kWh for coal, and 1.67 lb. for oil. Thus, (1.14 lb./kWh x 0.2435) + (2.25 lb./kWh x 0.0663) + (1.67 lb./kWh x 0.0422) = 0.497 lb./kWh.

EXHIBIT 3: SUMMARY OF LOCAL-LEVEL METRICS FOR BURLINGTON

GENERAL ENVIRONMENTAL BENEFIT	BURLINGTON BASELINE DATA	POTENTIAL BURLINGTON ENVIRONMENTAL BENEFIT	BURLINGTON DATA SOURCE
20 – 40 percent household-level VMT reduction from compact development	9,500 VMT per person per year (total)	1,900 – 3,800 VMT per person per year	Chittenden County/Vermont NHTS add-on sample
	0.86 – 0.93 lb. CO_2 per VMT	1,634 – 3,534 lb. CO_2 per person per year	N/A (value from literature)
Total CO_2 reduction from bus ridership	Unknown	Calculated per Exhibit 2	CCTA
4.4 percent residential energy savings from moving from a larger detached home to a smaller detached home	5,190 kWh electricity per residence per year (total)	228 kWh electricity per residence per year	Burlington Electric Department
	0.497 lb. CO_2 per kWh	113 lb. CO_2 per residence per year from electricity	Burlington Electric Department (fuel mix); EPA (emissions factors)
	900 ccf gas per residence per year (total)	40 ccf gas per residence per year	Vermont Gas
	12 lb. CO_2 per ccf gas	480 lb. CO_2 per residence per year from gas	N/A (value from literature)
20 - 37 percent residential energy savings from moving from a larger detached home to smaller apartment	5,190 kWh electricity per residence per year (total)	1,038 – 1,920 kWh electricity per residence per year	Burlington Electric Department
	0.497 lb. CO_2 per kWh	516 – 954 lb. CO_2 per residence per year from electricity	Burlington Electric Department (fuel mix); EPA (emissions factors)
	900 ccf gas per residence per year (total)	180 - 333 ccf gas per residence per year	Vermont Gas
	12 lb. CO_2 per ccf gas	2,160 – 3,996 lb. CO_2 per residence per year from gas	N/A (value from literature)

IEc

MEMORANDUM | September 30, 2011

TO Sandrine Thibault, Burlington Department of Planning & Zoning

FROM Kristen Sebasky, John Weiss, and Angela Helman, Industrial Economics, Incorporated

SUBJECT Task 3: Case Studies

INTRODUCTION

The City of Burlington's Department of Planning and Zoning tasked IEc with preparing case studies of successful or promising urban development strategies focused on alternative energy, transportation, green buildings, and/or green infrastructure, limiting the focus to communities or strategies that have potential transferability to Burlington. To identify these case studies, we drew upon our institutional knowledge and familiarity with the leaders across the sustainability movement, and worked directly with the Department to discuss potential candidates.

To maximize the cases studies' value to Burlington, IEc sought to identify communities that were comparable in size, character, political structure, climate, and geography. However, it was difficult to find communities that satisfied all of these criteria. IEc worked with the Department to ensure that the criteria used to establish comparability were appropriate for the case study topic(s). For example, similarities in community size and character may be important for issues related to density and transportation, but they may be less important in the context of green buildings and green infrastructure. For the latter, similarities in climate and geography may be more important than size and character. Also, we found that the most interesting and relevant case studies appeared to be from the western U.S.

The case studies IEc and Burlington agreed upon are:

- Bus passes and municipal parking in Boulder, CO;
- Municipal building energy retrofits in Berkeley, CA; and
- Stormwater management in Portland, OR.

IEc also agreed to include information related to other stormwater management-related initiatives, particularly initiatives that have tested innovative financing mechanisms. After reviewing available information, we elected to meet this objective by completing a short, fourth case study describing stormwater management financing in Philadelphia, PA.

IEc built off our exploratory research by conducting a thorough review of publicly available information for the selected case studies. In addition, we conducted interviews with local officials (see Appendix I for a list of contacts). Our questions focused on identifying key barriers and methods for overcoming those barriers, quantifying success where possible, and identifying lessons learned that are transferable to Burlington. We also used the interviews as an opportunity to explore whether and how other communities have integrated energy and environment initiatives into parallel efforts to promote and market a community's livability. IEc conducted phone interviews with at least one city official in each city; these officials included program coordinators, planners, and other policy makers.[1]

Our findings are summarized below. Given that the case studies focus on very different programs, we did not find many cross-cutting lessons learned. However, one common theme identified is the importance of ongoing communication and outreach for programs or policies that may encounter resistance, including communication and outreach to other relevant agencies, the business community, and the general public. Under Task 4, IEc will apply lessons learned from the case studies to the Burlington context.

BOULDER, CO: BUS PASSES AND MUNICIPAL PARKING

Background

The City of Boulder is a progressive, highly educated community with a strong history of action on environmental issues. The 1997 Kyoto Protocol piqued the Boulder community's interest in reducing greenhouse gas emissions and led to the development of two climate-oriented groups within the City's Transportation Division: the GO Boulder team and the Local Energy Action Division (LEAD). Although both of these groups focus their efforts on climate change, GO Boulder is primarily concerned with transportation. GO Boulder's initiatives include promoting a wide range of transportation options, such as biking (through bike sharing and bike corrals), public transportation (through the EcoPass program parking fees), and car sharing. GO Boulder's initiatives are designed to reduce carbon emissions in the City, as well as promote City livability. For the purposes of this case study, we focus on the EcoPass and parking fee programs.

Program Overview

The EcoPass is an unlimited-use bus pass for yearly access to all Regional Transportation District (RTD) transit services, offered at a group discount rate. The pass itself is a photo ID card. EcoPasses are available to employers to purchase for their employees to provide an incentive for taking public transit. Employer participation is voluntary. Participating employers must pay the cost of the EcoPass for all full-time employees with an option to include part-time employees, regardless of the number of employees who are interested in the pass. Employers in the downtown area do not need to provide EcoPasses; downtown employees receive them for free (see parking discussion below).[2]

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[1] Where we do not provide a citation for specific information provided in the case studies, the information came from phone interviews or email follow up with case study contacts.

[2] An overview of the EcoPass program is available at: http://www.rtd-denver.com/EcoPass.shtml

A second type of EcoPass, the "Neighborhood EcoPass," provides a group of residents (a neighborhood) with a group rate for the EcoPass, without having to receive the pass from an employer. A neighborhood is defined as all of the households in a particular geographic area; there is no minimum or maximum size for a neighborhood. Not all of the residents in the neighborhood are required to buy into the program, but the cost of the passes is based on the number of households in the neighborhood. Therefore, the households buying into the program may be paying more than the cost of the passes per household. For example, if the "neighborhood" consists of fifteen households but only ten buy into the program, the ten households will have to cover the cost of all fifteen households. However, in most cases, EcoPasses remain an economical option, as the cost of an individual yearly transit pass is approximately $2,000, while participation in the Neighborhood EcoPass program generally costs $100 to $200 per household. When a household purchases an EcoPass, it is valid for all family members.

The EcoPasses themselves are offered by RTD, but GO Boulder provides benefits beyond the group discount rate, including a 50 percent subsidy for the first year in the EcoPass program and a 25 percent subsidy in the second year (for both businesses and neighborhoods). An additional incentive is the EcoPass Extra program, which provides discounts at restaurants, stores, and other local businesses. In order to receive discounts, EcoPass holders must place the EcoPass Extra sticker on the back of their card. These stickers are provided by employers that support EcoPass. Finally, the EcoPass program offers a "Guaranteed Ride Home," which provides EcoPass holders with a free taxi ride home in an emergency (if they have used any transportation option other than driving to get to work).

GO Boulder also spends approximately $1 million per year investing in transit service above what RTD provides, to increase the availability and convenience of public transit. The GO Boulder service is called the Community Transit Network (CTN), which is also covered by the EcoPass. CTN includes name and branded buses, such as the HOP, SKIP, and JUMP buses. These buses run so frequently that schedules need not be provided – they generally come every ten minutes or less. This makes taking public transit an even more attractive option, beyond the monetary incentive of the EcoPass.

GO Boulder combined the EcoPass with a parking program to further reduce automobile use in the downtown area. The City used bonds and property taxes within the district to build shared parking structures, install parking pay stations, and improve signage at parking garages to reduce the amount of circling to find available parking spots. All downtown parking now costs $1.25 per hour, except on weekends. A portion of the revenue generated from parking fees is used to pay for EcoPasses for all downtown employees.[3] In 2010, about $750,000 in parking fees was used to cover the cost of EcoPasses used by downtown employees.

The GO Boulder program (as well as LEAD) is funded by sales and carbon tax revenues. Since 1967, the City has provided 6/10 of every cent paid in sales tax to the Transportation Division. The City also levies a carbon tax on residents and businesses based on their electricity use. Current tax rates are $0.0049 per kilowatt hour (kWh) for

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[3] Information on parking pricing can be found at: http://www.bouldercolorado.gov/index.php?option=com_content&task=view&id=899

residential users, $0.0009 per kWh for commercial users, and $0.0003 per kWh for industrial users.

Barriers and Strategies to Overcome Them

The major barrier the GO Boulder team faced with the EcoPass is that the majority of the transit system and the EcoPass itself are owned by RTD, a regional authority operating out of Denver. RTD is funded by taxes and not by transit ridership, and according to Boulder officials, has little incentive to increase transit ridership. RTD does not support the subsidies that GO Boulder offers on the EcoPass, and has tried to eliminate the GO Boulder plan politically. This is an ongoing issue between GO Boulder and RTD, but so far RTD has not been successful in undermining the GO Boulder program.

In addition to RTD, three main groups needed to be convinced that the EcoPass and parking fee programs were a good idea: the Chamber of Commerce, employers, and developers. The Chamber of Commerce is mainly concerned with economic vitality, and had to be convinced that these programs would be beneficial to the City economy. Both developers and employers had to be convinced that on-site parking is not always a necessity downtown. Developers have difficulty getting outside funding from investors when there is minimal parking available, because investors generally do not understand the transportation habits of Boulder residents. Similarly, employers tend to think that they need parking to attract employees and customers. However, Boulder residents walk, bike, and take public transit at a much higher rate than the U.S. average. Boulder's 2010 Report on Progress for their Transportation Master Plan states that "people in Boulder ride the bus at twice the national average, walk three times as much and bicycle at twenty times the national average." The LEAD team conducted extensive outreach to the business and residential communities to push these programs forward. Also, program managers indicate that communication of environmental and livability impacts to these groups is vital to success.

Measures of Success

The GO Boulder team conducts surveys every three years on employee and resident travel behavior. To date, the team has found that an employee or resident with an EcoPass is five to nine times more likely to take public transit compared to an individual without an EcoPass. Also, when an employer provides an EcoPass to its employees, about 38 percent of the employees will drive to work in a single occupancy vehicle (SOV), compared to 70 percent of employees that are not provided with an EcoPass.

With more employees using alternatives to get to work, there are more parking spaces available to visitors and customers in the downtown area. On-street managed parking spaces are nearly full at peak hours, but there is ample space available in the downtown area's shared parking structures. In fact, while there had previously been a waiting list for permits for the parking structures, there are now approximately 200 spaces available.

Next Steps

GO Boulder considers implementation of both the EcoPass and parking fee programs to be complete and successful. GO Boulder is also currently pursuing other means of encouraging alternative transportation, such as car and bike sharing opportunities.

BERKELEY, CA: MUNICIPAL BUILDING ENERGY RETROFITS

Background

The City of Berkeley began energy retrofits of municipal buildings in the early 1990s, with an emphasis on lighting, motivated by a desire to decrease utility bills as well as to demonstrate environmental leadership. This initiative is currently under the purview of the Office of Energy and Sustainable Development (OESD), which is responsible for implementing the City's Climate Action Plan (CAP). The main goal of the CAP is to achieve a 35 percent reduction in greenhouse gas (GHG) emissions from 2000 levels by 2020, and an 80 percent reduction from 2000 levels by 2050.[4]

Program Overview

OESD places a high priority on making municipal buildings more energy-efficient. Working cooperatively with the Department of Public Works, OESD staff seek to identify opportunities to incorporate energy efficiency retrofit measures into otherwise scheduled building maintenance activities. Retrofits generally include updated lighting, heating and ventilation systems, and building control systems, along with the addition of occupancy sensors for lights.

In 2000, OESD successfully petitioned to become the direct recipient of ratepayer funds that had previously gone to the public utility, based on the argument that the Office had better knowledge of community needs than the utility. With these funds, OESD created a non-profit organization called SmartLights. SmartLights focuses primarily on lighting retrofits, but has expanded its scope to other areas such as refrigeration and heating. The program performs technical audits and works with a group of contractors who perform retrofit jobs at pre-determined prices. The City often hires SmartLights to perform retrofits because of their reasonable price and technical expertise.

The City's general fund is typically sufficient to pay for smaller upgrades such as lighting retrofits. For large projects, the City often relies on all available utility rebates and financing. For example, Pacific Gas and Electric (PG&E) is currently offering zero percent financing for energy efficiency projects, enabling the City to repay loans through utility bill savings.

In addition to retrofits, the City has other initiatives in place to reduce building energy consumption. These include the requirement that all new municipal buildings acquire LEED Silver certification. Although new construction has been slow since the City adopted the LEED Silver requirement, to date, the City has built both an animal shelter and fire station with LEED Silver ratings. The City also promotes renewables where appropriate. Currently, several City buildings have solar PV or solar hot water technologies.

The City uses the U.S. EPA's Portfolio Manager to monitor energy savings, track energy costs, compare current energy consumption to benchmark conditions, and develop estimates of carbon emissions.

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[4] The Berkeley Climate Action Plan is available at: http://www.cityofberkeley.info/uploadedFiles/Planning_and_Development/Level_3_-_Energy_and_Sustainable_Development/Berkeley%20Climate%20Action%20Plan.pdf

Barriers and Strategies to Overcome Them

The City experienced few barriers to completing municipal building energy retrofits, due to the fact that these projects are relatively uncontroversial and are not widely publicized. The Berkeley community gives much more attention into commercial and residential energy retrofit projects, and has not provided any obstacles to the municipal retrofit projects. Also, since municipal building retrofits are just a small portion of the CAP, they have not been a topic of particular focus during recent Plan discussions.

As with most City projects, the main barrier to building retrofits is funding. Funds have decreased for lighting projects over the years, and retrofits can only be done when there is enough upfront funds and/or financing to support them. However, the recent zero percent financing offer from PG&E provides a great opportunity to move forward with substantial (high-cost) retrofit projects.

Throughout the implementation of building retrofits, OESD has identified the need to coordinate with other agencies, specifically the Department of Public Works. When the retrofits started in the 1990s, there was little communication between departments about these projects. Over the years, the Office has realized that coordination with Public Works is particularly beneficial, and maintenance projects now routinely include consideration of energy efficiency upgrade opportunities.

Measures of Success

The CAP goal for municipal buildings is simply to increase energy efficiency and renewable energy use in public buildings. To date, the City has saved 2.1 million kilowatt hours of electricity and 37,520 therms of heat (primarily natural gas) from energy conservation retrofit projects in municipal buildings. This equates to 1,200 tons of CO_2 emissions and an annual savings of $370,000 due to municipal building retrofits. [5]

However, at the time we completed this case study, the main CAP web page includes a chart indicating a trend in increasing overall municipal energy consumption.[6] According to City officials, this trend reflects the construction of new buildings, and masks the overall decrease in energy consumption by older buildings that have been retrofitted. Measuring total energy consumption can be misleading if the City is expanding its facilities as Berkeley has done. Berkeley officials suggest that it is more practical to normalize municipal energy use, by measuring energy consumption per square foot or number of employees, to track progress of energy efficiency initiatives. Also, it is not clear if municipal energy use tracked on the CAP website includes non-building energy use.

Next Steps

Moving forward, the City plans to continue retrofitting projects. They will continue to look for opportunities for retrofits or upgrades, and continue to use financing and rebate options to fund these projects. Currently, the City is in the process of a comprehensive analysis to identify these types of opportunities.

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[5] City of Berkeley website on municipal energy conservation: http://www.ci.berkeley.ca.us/ContentDisplay.aspx?id=33182

[6] City of Berkeley website on CAP progress: http://www.ci.berkeley.ca.us/ContentDisplay.aspx?id=19668

PORTLAND, OR: STORMWATER MANAGEMENT

Background

Stormwater runoff is a critical issue in Portland, due to its high amount of rainfall and high percentage of impervious surfaces. The City has a combined sewer system, and elevated levels of stormwater often cause the combined sewer to overflow, releasing untreated wastewater into the Willamette River. By state and federal law, the City is required through its Municipal Separate Storm Sewer System (MS4) permit and its Underground Injection Control (UIC) permit to reduce stormwater pollution and enhance water quality.

Since the 1990s, Portland has implemented a wide range of projects to manage stormwater. One of the efforts currently being undertaken by the City to manage stormwater is the East Side Big Pipe Project, part of a twenty year initiative to reduce stormwater flows. The goal of this project is to build a bigger pipe for the combined sewer system, so that a larger volume of stormwater and wastewater can be stored on the way to the treatment plant. (This is Portland's third Big Pipe project, following the Columbia Slough Big Pipe and the West Side Big Pipe.) This project is scheduled to be completed in December 2011, but over the course of the project stormwater and wastewater levels have increased beyond the capacity of the new pipe. Thus, in addition to conventional infrastructure solutions, the City is strongly interested in more sustainable ways to manage its stormwater, such as Green Streets.

Program Overview

In 2005, Portland's Commissioner of Public Utilities (and now Mayor) Sam Adams charged the City bureaus with developing an approach to implement Green Streets where feasible. A "Green Street" is a street that uses vegetated facilities with the following goals: manage stormwater, improve water quality, replenish groundwater, make streetscapes attractive, and improve access for pedestrians and bicyclists. Commissioner Adams' charge was split into two phases: (1) identify opportunities and challenges, and (2) evaluate options for implementation. The City assembled a cross-bureau team to address these charges.[7]

During Phase 1, the cross-bureau team developed a guidance document, which is now included in the City's Stormwater Management Manual.[8] This document provides details on the design of Green Streets and specifications for construction. The team also proposed an outreach plan during Phase 1, with implementation during Phase 2. This plan included: a PowerPoint presentation to present to community members, forums, Green Streets tours, a Green Streets door hanger, and Green Streets site markers. The Bureau of Environmental Services (BES) used the PowerPoint presentation to provide an overview of Green Streets other City bureaus, public agencies, and community groups. They used the forums to address the technical aspects of Green Streets, and offered tours of Green Streets facilities to discuss particular projects and site-specific issues. BES used the door hanger to provide general information on Green Streets and remind community members of their importance, as well as site markers to inform the community about

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[7] Information on the Green Streets program is available at: http://www.portlandonline.com/BES/index.cfm?c=44407&

[8] The Stormwater Management Manual is available at: http://www.portlandonline.com/bes/index.cfm?c=47952

where Green Street facilities are located and to promote maintenance of these facilities. More details on outreach and an image of the door hanger can be found in the Green Streets Cross-Bureau Team Report, Phase 2.[9] Phase 1 reached completion in 2006.

The team initiated Phase 2 in 2006, during which they wrote a citywide Green Streets policy which they presented to the City Council for approval. The policy establishes the support of the City Council for the Green Streets program, ensuring that the City Council will implement Green Streets as part of public infrastructure programs, and integrate the Green Streets Policy into other City documents, including the Portland Comprehensive Plan, Transportation System Plan, and Citywide Systems Plan. The City Council approved this policy in 2007.

A common theme in the Green Streets reports was collaboration. The group in charge of Phase 1 and 2 of the Green Streets project, the "Green Streets Cross-Bureau Team," included members from the Bureau of Environmental Services (BES), the Office of Sustainable Development, the Office of Transportation, the Bureau of Planning, the Commissioner's Office, Parks and Recreation, the Portland Water Bureau, the Portland Development Commission, and the Bureau of Maintenance. Since the passage of the Citywide Policy in 2007, BES and the Development Commission have been the main groups charged with implementation, but all City departments are required to follow the policy.

The Green Streets program is funded by capital dollars and the City's general fund. The City has made significant investments of capital dollars for CSO projects, and BES has diverted some of these funds from pipe-building projects to sustainable management practices such as Green Streets. Also, transportation enhancement projects fund some Green Street facilities, as all new city infrastructure is required to consider Green Streets (in the citywide policy). When new development projects have difficulty funding Green Streets, they can access Portland's "One Percent for Green" fund, which can be used to construct Green Street facilities that reduce stormwater runoff in public rights-of-way.[10] Construction projects within the right-of-way that fall outside the requirements of the Stormwater Management Manual are required to contribute one percent of construction costs to this fund.

Maintenance is a crucial part of the Green Streets program, and is the responsibility of the City. Dedicated staff within the Watershed Revegetation Program visit the facilities at least twice per year to perform maintenance. In addition, BES is continuously working on ways to improve maintenance as the number of facilities grows. The Sustainable Stormwater Management Division, within BES, has recently implemented a program called the "Green Streets Steward Program." Through this program, community members volunteer to become "stewards" of Green Streets, providing maintenance such as weed removal, plant trimming, and trash cleanup.[11] So far, according to program managers, the steward program has been a success. Following the launch of the steward program, twenty-four residents adopted a total of thirty Green Street facilities. BES is

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[9] The report is available at: http://www.portlandonline.com/shared/cfm/image.cfm?id=153974

[10] Information on the fund can be found at: http://www.portlandonline.com/BES/index.cfm?a=341452&c=44407

[11] Information on the Steward Program can be found at: http://www.portlandonline.com/BES/index.cfm?c=52501&

also trying to identify plants and facility types that can be more efficient and require less maintenance.

The goals of Green Streets go beyond stormwater management; Green Streets are also meant to improve pedestrian safety and aesthetics. Additionally, Green Streets are being used as “connectors” between businesses, parks, transit facilities, and other infrastructure elements.

Barriers and Strategies to Overcome Them

BES faced a few barriers in program implementation including: funding, plant selection, government cooperation, and community acceptance. As with most government projects, funding was and is a major issue. In addition, BES experienced difficulty in identifying the best plant types to be used in Green Street facilities, as the plants chosen must be resilient to extreme weather conditions and less than three feet tall. Plant selection is an ongoing, iterative process, and project managers note that plant choices are crucial to project success. The correct choice of plants can assist in pleasing the community and reducing maintenance requirements. Also, because of the bureau structure in the City, BES faces barriers to Green Streets implementation across bureaus. Each City bureau is headed by a different city council member, which makes coordination difficult. However, BES has worked successfully with the planning and transportation bureaus to implement Green Streets.

To help engage the community and gain their acceptance of the Green Streets projects, the City provides multiple outreach programs. BES has found that outreach to both other agencies and the public is essential to program success. BES has a group of staff members specifically devoted to outreach. These staff talk to property owners adjacent to Green Street facilities to educate them and to survey their concerns. Other outreach strategies include holding public meetings and requesting input from nearby residents on the kinds of plants to use. When parking spaces are removed for Green Street facilities, the projects can be very controversial, and outreach is vital. When there is extreme pushback about a particular Green Street facility, BES tries to scale back or shift the facility in order to assuage complaints

Finally, BES has found that landscape architects are as vital to the process as engineers, as the appearance of facilities to community members can be as important as the public as the stormwater management services provided by them. BES now employs five landscape architects to assist with the design of Green Streets.

Measures of Success

Portland has constructed approximately 1000 Green Streets, and about 200 community members and property owners are on a waiting list to have a facility constructed in their neighborhood; the City will consider these projects as funding is available. The City has monitored runoff flows to quantify the success of Green Street facilities and other stormwater management projects using green infrastructure. So far, the City has released monitoring reports in 2006, 2008, and 2010. In the 2010 report, the City’s results indicate on average, a 90 percent reduction in peak flow from green infrastructure facilities, and an average retention of 80 percent of rain water annually.[12] These results indicate that green infrastructure facilities are effective at reducing burden on the City's CSO system. However, City staff indicated that the effectiveness of individual green infrastructure facilities can vary according to a number of factors, including antecedent conditions, maintenance frequency and completeness, and physical elements of the facility (slumped check dams, partially clogged drains, etc.).

Next Steps

The City of Portland is continuing to construct Green Streets, as funding allows. BES is continuing to modify the list of plants used in Green Street facilities, so that facilities may be more efficient and require less maintenance. In addition, BES is continuing to change designs to adapt to new locations, including more urban areas. BES hopes to continue innovation and identification of new opportunities and technologies.

In addition, the City is currently implementing its "Grey to Green" program, a $55 million dollar investment to promote their watershed management plan.[13] The funding is a combination of capital improvement dollars, City general funds, and stormwater utility ratepayer dollars. This program includes the construction of 920 new Green Street facilities. As of August 2010, 325 of these Green Streets had been constructed, which is included in the total of 1000 Green Streets constructed.

PHILADELPHIA, PA: STORMWATER MANAGEMENT INCENTIVES PROGRAM

Background

Stormwater management is a critical issue in the city of Philadelphia. In the 1990s, the Philadelphia Water Department (PWD) held a series of public engagements to develop a plan for managing stormwater in compliance with EPA regulations. The outcome of these groups was a change in stormwater user fees. Previously, PWD charged stormwater fees on a meter-based system. Therefore, larger buildings were paying higher stormwater fees than smaller buildings, regardless of their stormwater management practices. PWD changed this system so that stormwater fees are charged based on a building's amount of impervious surface area, resulting in much higher stormwater fees for smaller building owners. Not surprisingly, this change did not sit well with the smaller building owners, leading a local non-profit organization, the Philadelphia Industrial Development Corporation (PIDC), to seek an alternative solution. The result was the development of the Stormwater Management Incentives Program (SMIP) in 2010.[14]

Program Overview

SMIP is a program through which business owners can receive low-interest loans for stormwater management projects. PWD is currently providing a $5 million fund for the program. Loan amounts range from $75,000 to $1,000,000, with a one percent fixed

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[12] City of Portland, *Stormwater Management Facilities Monitoring Report*, December 2010, p. S-5, http://www.portlandonline.com/bes/index.cfm?c=36055&a=343463

[13] Information on Grey to Green is available at: http://www.portlandonline.com/bes/index.cfm?c=47203&a=321331

[14] Information on SMIP is available at: http://www.phila.gov/water/Stormwater/pdfs/SMIP.pdf

interest rate. The loan term is up to 15 years, consistent with the payback period for stormwater management measures. The program does not apply to residential property owners, as residential stormwater user fees are much less of a burden than commercial fees.

Barriers and Strategies to Overcome Them

PIDC did not experience any significant barriers in the implementation of SMIP. PWD is strongly interested in promoting stormwater management, and was willing to provide funding for this program.

Measures of Success

SMIP began in late 2010, and already has three applicants. These include a $200,000 loan for a green roof and porous pavement for a non-profit company and a $230,000 loan for a retention basin at an auto dealership. In addition, many property owners have showed interest in the program, but are still in the process of developing plans with engineering firms.

Next Steps

PIDC is continuously working with PWD to identify opportunities in assisting property owners with stormwater management. They are considering options to increase funding for SMIP, along with funding to support property owners with the engineering costs involved in developing stormwater management plans. Also, they will continue to manage SMIP as funding allows.

IEc

APPENDIX I: LIST OF CASE STUDY CONTACTS

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IEc

MEMORANDUM | September 30, 2011

TO Sandrine Thibault, Burlington Department of Planning & Zoning

FROM Dan Leistra-Jones and Angela Helman, Industrial Economics, Incorporated

SUBJECT Task 4: Implementation Recommendations

INTRODUCTION

The City of Burlington, Vermont is currently in the process of developing a land use and development master plan for its downtown/waterfront area. The City envisions a plan that actively promotes climate-conscious development and transportation strategies. As a part of that process, the City's Department of Planning & Zoning (DPZ) contracted Industrial Economics, Incorporated (IEc) to conduct a Climate, Energy and Green Infrastructure Analysis. This analysis consisted of:

- Task 1: IEc assessed the City's current practices and future plans to identify potential opportunities and challenges associated with enhancing energy efficiency and green buildings, renewable energy, green infrastructure, and transportation in the downtown/waterfront area.
- Task 2: IEc developed information helpful for assessing potential greenhouse gas (GHG) emissions reductions that could be realized by promoting additional development in downtown Burlington, rather than at the suburban fringe.
- Task 3: IEc prepared three case studies of successful or promising strategies employed in other cities, focused on transportation, building energy efficiency, and green infrastructure.

IEc's work on the above tasks included a review of Burlington's key planning documents, literature review, identification of relevant programs in other cities, and interviews with Burlington officials as well as officials in other cities.[1]

IEc found that Burlington is already making great strides on sustainability and is at the forefront of local government response to climate change. The City developed a Legacy Project Action Plan in 2000 to provide a 30-year road map to becoming a sustainable community, and since that time, Burlington has laid a solid foundation for advancing a robust sustainability and livability agenda.[2] Specifically, IEc found that Burlington's holistic and comprehensive approach to sustainability, which encompasses complementary strategies on transportation, land use, building energy, and green infrastructure, is a wise approach. As discussed in the Task 2 memorandum, changes in density alone are unlikely to have a

[1] As a foundation for this work, IEc reviewed a number of key planning documents selected by DPZ, including: Burlington's Comprehensive Development Ordinance; The 2006 Municipal Development Plan; A draft set of actions and descriptions from the City's Climate Action Plan (CAP);Chapter 26 Wastewater, Stormwater, and Pollution Control; Department of Public Works Stormwater Credit Manual; Phase II Stormwater 2010 Annual Report; Moving Forward Together: Transportation Plan for the City of Burlington; Burlington Downtown and Waterfront Plan Transportation Study; Land Use Inventory and Buildout Analysis. See Task 1 memo for citations.

[2] The Burlington Legacy Project. "Burlington Legacy Project Action Plan: Becoming a Sustainable Community." June 2000. Available at: http://burlingtonlegacyproject.org/files/2009/07/LegacyActionPlan.pdf

significant impact on citywide GHG emissions; the literature suggests that doubling residential density will result in only a five percent decrease in vehicle miles traveled (VMT) and corresponding GHG emissions.[3,4] However, a comprehensive approach that combines 1) several aspects of compact development, including enhanced pedestrian orientation, a robust mix of land uses, increased public transportation accessibility, with 2) building energy use reduction strategies, deployment of renewable energy, and green infrastructure strategies, can have a much more significant environmental impact over the long run. Such a multifaceted approach will be necessary to meet the City's sustainability and GHG reduction goals. However, IEc understands that Burlington already has many sustainability and climate change policies and programs underway. Thus, the City needs to ensure that current policies and programs have the resources needed to succeed. Burlington should be careful to undertake only those policy changes or new programs that can make a clear contribution to the City's goals, and can be sustained over time.

To this end, IEc provides a set of recommendations in this memorandum for the City to consider as it moves forward with its sustainability agenda. These recommendations are based on IEc's understanding of Burlington's context, project research, and institutional knowledge of planning and sustainability best practices. We have organized the memorandum by providing key recommendations first, followed by secondary recommendations in each of four topic areas: green building and energy efficiency, renewable energy, green infrastructure, and transportation. Our intention is for DPZ to use the recommendations provided in this memorandum as an input into the City's ongoing master planning process.

KEY RECOMMENDATIONS

Land Use Planning and Policy Recommendations

Although land use planning and policy issues were not called out specifically as one of the four topic areas for IEc to assess, we found that Burlington's land use planning and policy framework is an area where current policies may be undermining the City's climate change strategy and GHG goals. Thus, IEc provides the following recommendations in this area:

Adopt a form-based code (FBC). IEc found that on balance, Burlington's policy and planning framework allows for a mix of uses in the downtown/waterfront area. The Municipal Development Plan (MDP) sets a strong vision for a sustainable Burlington and recognizes that the economic and cultural strength of the downtown area relies on compact, mixed-use development reflective of the City's architectural and historic heritage. The Comprehensive Development Ordinance (CDO) permits building uses and prescribes set-backs and building heights that are generally consistent with this vision. The MDP and buildout analysis suggest that opportunities exist to increase density in the downtown/waterfront area.

However, IEc recommends that Burlington shift its zoning code from conventional use-based zoning to a form-base code (FBC) to facilitate future development that conforms to the City's sustainability plans. FBCs use physical form rather the separation of uses as the organizing principle for development. They are prescriptive solutions that focus on identifying the types and features of development desired by the community at specific locations, in contrast with conventional zoning, which use a less precise approach to regulating land use.

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[3] Ewing, Reid and Robert Cervero. "Travel and the Built Environment: A Meta-Analysis." Journal of the American Planning Association 76(3), Summer 2010. P. 275.

[4] Walters, Jerry and Reid Ewing. "Measuring the Benefits of Compact Development on Vehicle Miles and Climate Change." Environmental Practice 11(3), September 2009. P. 205.

FBCs are typically organized by transects that travel from the most dense (e.g., downtown) to the least dense areas (e.g., exurban/agricultural areas). Each block along the transect is assigned prescribed forms for building height and character. Uses can be designated, but are secondary to the form designations. Since FBCs regulate development at the scale of an individual building or lot, they encourage independent development by multiple property owners. This eliminates the need for complex land assemblies that large projects frequently require under conventional zoning.[5] Typically organized with visual displays and concise, plain language descriptions, FBCs are easier to understand than conventional zoning, encourage participation of nonprofessionals in the development process. Also, FBC core elements of accessibility and transparency help foster active public participation in the planning process.[6]

Through the use of FBCs, Burlington would have more control over land use than conventional zoning, allowing the City to predictably and effectively implement policies and programs that are crucial for reducing GHG emissions and realizing the City's sustainability and livability goals. FBCs have been shown in many communities to be more effective than conventional zoning in realizing densities and better pedestrian orientation, and a reduction in auto dependency.[7] For example, Petaluma, California used a form-based code adopted in 2003 to revitalize its downtown area of approximately four hundred acres. The City adopted the FBC specifically to respect the heritage of the city while bringing more pedestrian and economic activity into underutilized areas.[8]

In contrast, the problem with conventional zoning is that it is a comparatively abstract and imprecise tool for realizing a community's vision, which often results in development that is uncoordinated, unintended, and lacking in adherence to a community's land use planning and sustainability goals. A recent American Planning Association article summarized the power of form-based codes by stating: "Form based codes are proving indispensable for communities that want a broad application of walkable urbanism, to make new auto dependent areas the exception rather than the norm."[9]

FBCs can also be crafted to include provisions that prescribe the location and development of renewable energy installations, transportation nodes, and green infrastructure measures, which are all important features of Burlington's plans. For example, the City of Flagstaff, Arizona recently conducted a city-wide code update, in which it transformed its conventional use-based zoning to a FBC. Flagstaff conducted extensive studies to understand the optimal locations for renewable energy installations (primarily wind and solar) and the types of systems (e.g., ground versus roof-based) that were appropriate along each section of the transect. A similar process was carried out with regard to stormwater management and green infrastructure, determining the appropriate locations for specific stormwater best management practices (BMPs). The studies' results were incorporated directly into the FBCs, which will reduce the need for time-consuming variance procedures and/or zoning changes to construct these installations.[10,11] IEc recommends that Burlington consider codifying allowable locations and types of renewable energy

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[5] Form Based Codes Institute. Available at: http://www.formbasedcodes.org/. Accessed July 18, 2011.

[6] Katz. P. "Form First: The New Urban Solution Conventional Zoning." Form Based Codes Institute, November 2004. Available at: http://formbasedcodes.org/articles?page=2.

[7] Brad Broberg. "New Kind of Zoning, Cities of All Kinds Adopting Form-Based Codes." *On Common Ground*, a publication of National Association of Realtors, Winter 2010. See also Bill Spikowski. "Form-Based Codes." *Florida Planning*, Winter 2010.

[8] John Barry, "Form-Based Codes: Measured Success Through Both Mandatory and Optional Implementation," *Connecticut Law Review*, Fall 2008. Available at: http://connecticutlawreview.org/archive/v41n1/barry305.pdf

[9] Alan Massomer. "The Frontier of Form-Based Codes." APA *Journal of Regional and Intergovernmental Planning*, Fall 2010. Available at: http://www.formbasedcodes.org/files/APAregional_newsletter_Win2011.pdf

[10] Parolek, D. "Form-Based Codes and Sustainability: Two Case Studies." Presentation at the New Partners for Smart Growth Workshop. Charlotte, NC. February 3, 2011.

[11] For more information on the Flagstaff form-based code, see http://www.flagstaff.az.gov/index.aspx?NID=1416.

installations in particular within an FBC. In addition, we recommend that the FBC indicate that green infrastructure installations and green roofs in particular are allowed and encouraged in the downtown/ waterfront area in particular, which is serviced by an older combined sewer system.

The development of FBCs will require an extensive overhaul of the City's policy and planning framework documents, and will likely require changes to processes and procedures that have been in place for decades. The City should plan on educating community members about FBCs and their benefits.. Extensive outreach will be necessary to communicate these changes to residents, business owners, and the development community. It will also take patience and a certain measure of political will.

Revisit restrictions on housing in the downtown/waterfront area. Burlington's current planning framework recognizes the importance of housing in the downtown and waterfront areas, but overly restricts housing development. Most importantly, the CDO states that no more than 50 percent of the gross floor area developed can be residential in the downtown/waterfront area.[12] Limiting housing in the downtown area conflicts with the goal of making Burlington's downtown a more vibrant, livable place that continues to attract new residents. Planning research suggests an optimal ratio of approximately 1.5 jobs per housing unit; by contrast, Burlington's downtown currently has a much higher ratio of about 5 to 1.[13,14] This suggests that significantly more housing is needed to bring Burlington's downtown into balance. As such, IEc recommends eliminating the restrictive housing policy.

Results from the Task 2 analysis suggest that increasing housing availability in the downtown/waterfront area is an important strategy for reducing household-level environmental impacts and transportation costs, because living closer to work cuts commuting distances and emissions, and because living in a walkable area (i.e., close to retail and other key destinations) reduces non-commuting driving as well. A major meta-analysis estimated that overall, residents living twice as close to downtown have 22 percent lower VMT.[15] This suggests that increasing housing availability in downtown could result in dramatic reductions in driving.

Moreover, IEc's Task 2 analysis also indicates that urban housing tends to use less energy for heating than suburban housing, because households tend to downsize in square footage when moving into an urban area, and because urban, multi-family housing requires less heating due to shared walls as well as the urban heat island effect. For example, one study estimated that a family moving from a 2,400 sq. ft. detached single-family home to a modestly smaller 2,000 sq. ft. apartment would save an average of 37 percent of total energy use,[16] worth about $766 annually at Burlington's current energy costs and consumption levels.[17]

IEc understands that to retain the character of the downtown area, Burlington may want to restrict housing form in some way, such as the current prohibition of residential dwellings on the first floor of a building.

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[12] CDO. 4.4.1(d)1.B Residential/Nonresidential Mix Required.

[13] Weitz, Jerry. "Jobs-Housing Balance." American Planning Association Planning Advisory Service, Report Number 516. November 2003. Available at: http://www.planning.org/pas/reports/subscribers/pdf/PAS516.pdf

[14] Personal communication, David White, Burlington Department of Planning & Zoning. August 17, 2011.

[15] Ewing, Reid and Robert Cervero. "Travel and the Built Environment: A Meta-Analysis." Journal of the American Planning Association 76(3), Summer 2010. P. 275.

[16] Kockelman, K. et al. "GHG Emissions Control Options: Opportunities for Conservation." University of Texas, Austin, 2009. Available at: http://onlinpubs.trb.org/Onlinepubs/sr/sr298kockelman.pdf. Cited in Transportation Research Board 2009, pp. 175, 199.

[17] For energy costs, see https://www.burlingtonelectric.com/page.php?pid=11&name=residential_rates and http://www.vermontgas.com/residential/res_rates.html Consumption data is from personal correspondence with Chris Burns, Burlington Electric Department, and Scott Harrington, Vermont Gas, June 28 and 29, 2011.

This type of restriction does not conflict with City's sustainability plans because it affects the form of residential development but does not unduly limit quantity.

Reconsider current parking policies. Burlington should reconsider its parking policies, for a number of reasons. First, Burlington's no net loss parking policy and off-street parking minimums in the downtown/waterfront area are in conflict with the City's sustainability goals. To move City residents towards public transportation for commuting and walking in the downtown area, both of which are necessary for realizing the City's GHG emission goals, the cost of parking needs to rise. Otherwise, many residents will not have sufficient incentive to consider transportation alternatives. Once the cost of parking rises, however, demand for parking should decrease to a certain degree, and Burlington should naturally need less parking than it does today. Thus, Burlington should consider increasing parking meter rates and garage rates. We also note that the City provides most downtown municipal employees with free parking passes; charging for these passes or providing flexible passes rather than giving away full-time passes could further help to reduce parking demand.[18] In addition, if Burlington limits parking through conversions of existing parking lots to other uses, then the market rate of parking may rise, and may naturally help to reduce demand.

Secondly, the current low cost of parking in downtown Burlington represents a missed opportunity to raise revenues that the City could use for parking and transportation improvements. Increased meter and garage rates will generate additional revenue. The City should also consider allowing cash-in-lieu of parking to create additional revenue. The revenues collected through cash-in-lieu of parking and higher parking fees could fund more strategically located garage parking (the locations of which should be identified by the master plan and reflected in the FBC), and/or street design and traffic control improvements. Alternatively, Burlington could use the parking funds to promote other aspects of its sustainability vision, such as pedestrian improvements or even green building or green infrastructure.

Boulder, Colorado, which recently implemented a comprehensive transportation and parking plan, provides an example of a city that raised parking rates without negatively affecting the economic growth and vitality of its downtown area. While the City's sales tax revenue decreased in 2009 due to the nationwide economic downturn, it has since recovered, indicating that local businesses are performing well. Redevelopment projects in the downtown area indicate a continuing high demand for commercial real estate there. City officials believe that businesses continue to locate in the downtown area due to its lively atmosphere and its ready accessibility by foot, bike, or bus; higher parking fees have not had any noticeable effect in discouraging businesses from locating downtown or reducing customer traffic.[19]

Changes to parking policy could be coupled with piloting innovations such as demand-responsive meter rates and shared parking. The Technical Appendix to the City's transportation plan makes a strong case for a market-based approach, advocating setting prices to ensure that utilization during peak periods reaches 85 percent.[20] IEc's research indicates that cities have been successful with this approach. For example, Redwood City, California uses demand-responsive meter rates that produce an average 18 percent availability rate in the downtown area. The average parking stay is 72 minutes. Before program implementation, these spaces were always occupied by day-long employees. Now, the program provides

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[18] Burlington Sustainability Action Team. Memorandum Re: Employee Commute Downtown Pilot Program. June 11, 2011.

[19] Personal communication, Chris Hagelin, GO Boulder. August 16, 2011.

[20] City of Burlington, Vermont, Department of Public Works, Department of Planning and Zoning, Community and Economic Development Office. Moving Forward Together: Transportation Plan for the City of Burlington. Technical Appendix. March 2011.

greater access for more shoppers and visitors.[21] For an example of shared parking, the City of Monrovia, California has a six-by-two block "old town" downtown area. It previously had approximately 1,200 free surface and on-street parking spaces, which were underutilized. When the City developed a new movie theater complex in 1997, it implemented a shared parking system to be shared by daytime and evening uses. This approach allowed the City to cut the number of spaces while accommodating new parking demand from the theater complex.[22]

Other Key Recommendations

IEc provides the following additional recommendations in areas including transportation, building energy, green infrastructure, and outreach and communications.

Take steps to ensure the success of the new transportation plan. Burlington's Transportation Plan sets a preliminary goal to increase annual transit ridership by five percent annually. With the implementation of the additional transit services advocated by the Plan, transit ridership will increase gradually over time. IEc recommends that the City take steps to ensure that this ridership goal is met coupled with the expected environmental benefits.

The Chittenden County Transportation Authority (CCTA) is starting from a position of relatively infrequent bus service, and thus increasing service frequency on key routes is an appropriate first step towards increasing ridership. In its 2010 Transit Development Plan, the CCTA notes that most of its buses provide service every 30 minutes. The plan states that:

> "In the transit industry, 30-minute service is considered unattractive to choice riders, while 15-minute service in the peak periods is considered a significant threshold to make transit competitive with driving. Establishing 15-minute peak service on all four of the major corridors into Burlington – North Ave., Colchester Ave./Pearl Street (VT 15), Williston Road/Main Street (US 2), and Shelburne Road (US 7) – is likely to be the most cost-effective investment in new service that CCTA can make. This is the central transit recommendation in the Burlington Transportation Plan."[23]

While increased frequency may be necessary, it might not be sufficient to increase ridership by five percent annually; incentives to use transit (and/or disincentives to drive) will also be important to spur additional ridership. Indeed, our literature review in Task 2 suggests that after a certain point, increased service frequency is not likely to have much effect on increasing ridership. Under Task 3, IEc details Boulder, Colorado's efforts to increase transit ridership through its EcoPass program, which provides discount bus passes and additional perks for employees and neighborhood groups. Boulder's effort has been quite successful, and could provide a useful model for Burlington. The EcoPass is an unlimited-use bus pass for yearly access to all area transit services, offered at a group discount rate. EcoPasses are available to employers to purchase for their employees to provide an incentive for taking public transit. Employers in the downtown area do not need to provide EcoPasses; downtown employees receive them for free. A second type of EcoPass, the "Neighborhood EcoPass," provides a group of residents (a neighborhood) with a group rate for the EcoPass, without having to receive the pass from an employer.

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[21] Seattle Department of Transportation. "Best Practices in Transportation Demand Management." Seattle Urban Mobility Plan. January 2008. Available at: http://www.seattle.gov/transportation/docs/ump/07%20SEATTLE%20Best%20Practices%20in%20Transportation%20Demand%20Management.pdf.

[22] Victoria Transport Policy Institute, "Shared Parking: Shared Parking Facilities among Multiple Users," Victoria Transport Policy Institute, http://www.vtpi.org/tdm/tdm89.htm.

[23] Chittenden County Transportation Authority. "Transit Development Plan: Executive Summary." September 20 10. Available at: http://www.cctaride.org/pdf/Documents/ExecutiveSummary.pdf

GO Boulder provides additional benefits beyond the group discount rate, including a 50 percent subsidy for the first year in the EcoPass program and a 25 percent subsidy in the second year (for both businesses and neighborhoods). The EcoPass program also offers a "Guaranteed Ride Home," which provides EcoPass holders with a free taxi ride home in an emergency (if they have used any transportation option other than driving to get to work).[24]

Surveys by the Boulder transit operator have shown that an employee or resident with an EcoPass is five to nine times more likely to take public transit compared to an individual without an EcoPass. Also, when an employer provides an EcoPass to its employees, about 38 percent of the employees will drive to work in a single occupancy vehicle (SOV), down from 70 percent of employees when EcoPass is not provided.

In Burlington, the CCTA's Smart Business program could be a useful tool for encouraging transit ridership. Similar to Boulder's employee EcoPass program, one current option of the Smart Business program is for businesses to purchase monthly passes for their employees for all CCTA buses; other options are less generous. The program also includes a guaranteed ride home in case of emergency.[25] The City should lead the way in providing Smart Business incentives to municipal employees, which would promote awareness and could drive increased demand for Smart Business passes among other employers. Although Burlington's City government has enrolled in this program, it has done little to encourage staff members to participate.[26]

An aggressive communications and outreach effort would help Burlington promote awareness of transit incentive programs initiated in the City. These efforts could also discuss the environmental and financial benefits of transit use. We discuss recommendations for outreach and communications in greater detail below.

In addition to providing incentives for using transit, we also encourage Burlington to provide disincentives to driving. We discussed potential changes to Burlington's parking policy above. We do not repeat that entire discussion here, but it bears repeating that a reduction in the number of parking spaces, or an increase in the price of parking, would have the effect of discouraging driving and encouraging alternative means of transportation. By the same token, making parking cheaper or more abundant will encourage driving and discourage transit use. Thus, Burlington's current policy of no net parking loss is at odds with the City's aim of increased ridership.

Once Burlington has begun implementing its transportation plan, we recommend the City monitor key performance metrics to evaluate implementation and make changes as needed. As discussed in the Task 2 memorandum, increased transit ridership should not be considered an end in itself; rather, it should be viewed as a means to reduce energy use and GHG emissions, as well as to reduce traffic. Also as discussed in the Task 2 memorandum, the average U.S. bus running on diesel fuel needs to carry 11.7 passengers (at all times) to achieve any GHG emissions reductions over automobiles; below this level, buses actually emit more GHG emissions than cars.[27,28] (The break-even point would be lower for buses using a lower-emission fuel, such as natural gas or a biodiesel blend.) Thus, if the City's underlying motivation is environmental protection, Burlington should measure transportation fuel use and GHG

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[24] An overview of the EcoPass program is available at: http://www.rtd-denver.com/EcoPass.shtml

[25] Chittenden County Transportation Authority. "Program Overview for Employers: CCTA Smart Business." No date. Available at: http://www.cctaride.org/pdf/smartbusiness/smartbiz-employers.pdf

[26] Personal communication, Jennifer Green, Burlington Community and Economic Development Office. August 11, 2011.

[27] Department of Energy Center for Transportation Analysis. "Transportation Energy Data Book." Edition 29, June 30, 2010. Table 2-12. Available at: http://cta.ornl.gov/data/index.shtml

[28] I.e., 39,906 Btu per vehicle-mile / (5,465 Btu per vehicle-mile / 1.6 passengers) = 11.7 passengers.

emissions, rather than focusing exclusively on transit ridership. We discuss specific transportation-related performance metrics and data sources in greater detail below.

As a final note, we recommend that Burlington use its transit system to guide decisions on where to promote further development, rather than vice versa. This aim is already reflected in the City's transportation plan, which states that "Transit services should be provided where higher-density, mixed-use development is anticipated well in advance, rather than re-routed in response to new development proposals after that fact."[29] A proactive approach is likely to be more effective over the long term in encouraging both more compact development and greater transit usage.

Develop a re-commissioning program for the City's older building stock. The City's current energy efficiency programs primarily focus on achieving efficiencies at the time of construction and initial commissioning. Over time, systems operations may cease to work in peak condition due to typical wear and tear, human error, changes in building operations, weather conditions, or other reasons. Re-commissioning (also known as retro-commissioning) includes testing and adjusting building systems to meet the original design intent and/or optimizing systems to satisfy current operational needs.[30] Re-commissioning is particularly important for older building stock in climate zones that experience extreme heat or cold (such as Burlington). The re-commissioning process can yield significant energy and cost savings at the building level. For example, in 2004, Xcel Energy conducted a re-commissioning of an older 500,000 square-foot hotel in Bloomington, Minnesota. The process, which cost $340,000, found a number of ways to improve the efficiency of the HVAC system, earning $40,000 in energy efficiency rebates. Those rebates, along with estimated energy savings of 495,000 kilowatt-hours per year, resulted in a relatively short payback period of 2.3 years.[31]

The City should consider developing a program that provides incentives for or requires building re-commissioning. Burlington should require City buildings and schools to undergo re-commissioning on a fixed schedule, such as every five years. For privately-owned buildings, Burlington could require or incentivize re-commissioning at the point of sale. The California Commissioning Collaborative is currently testing an approach of integrating commissioning and disclosure of energy performance at the point of sale. The Collaborative is using a building walk-through to assess energy savings potential of assets and operations, and develop cost and energy savings estimates. The idea is for this energy information to be provided to a building's current and future owners prior to finalizing sale of the property.[32]

Develop a strategic plan for Burlington's green infrastructure initiatives, and ensure available resources to support it. Burlington is currently engaged in several efforts to reduce stormwater impacts and promote green infrastructure. IEc recommends that Burlington develop a strategic plan to guide future investments in this area. As discussed in the Task 1 memorandum, current staffing is inadequate to

[29] City of Burlington Department of Public Works, Department of Planning and Zoning, and Community Economic Development Office. "Moving Forward Together: Transportation Plan for the City of Burlington." Adopted March 28, 2011, p.15. Available at: http://www.ci.burlington.vt.us/docs/4593.pdf

[30] Similarly, continuous commissioning™, a more costly option, utilizes integrated equipment and computers to constantly monitor and adjust building operations to meet peak performance. U.S. Department of Energy. "Federal Energy Management Program." Available at: http://www1.eere.energy.gov/femp/program/om_comtypes.html.

[31] Xcel Energy, Inc. "Recommissioning." January 2010. Available at: http://www.xcelenergy.com/staticfiles/xe/Marketing/Case-Study-RCx-hotel.pdf.

[32] California Commissioning Collaborative. "Energy Transparency in Commercial Real Estate Transactions." Available at: http://www.cacx.org/PIER/realestate.html

support the program, and the stormwater fee does not provide an adequate incentive for installing green infrastructure. To develop a strategic plan, City officials should:

- Develop a few scenarios for the potential size and scope of a long-term municipal green infrastructure program. For example, program size parameters could include the annual number of green infrastructure technical assistance engagements that the City takes on. Program scope parameters could include assumptions about Burlington's responsibilities for maintaining green infrastructure facilities over time.
- Analyze funding needs in terms of staffing and other operating costs for each scenario over time.
- Analyze the potential for stormwater fees and other potential revenues to meet the funding needs estimated under each scenario.

Portland, Oregon, a recognized leader in stormwater management and green infrastructure, undertook a similar review in the 1990s when it began developing its stormwater management plan.[33] This type of analysis will help to identify a sustainable green infrastructure program size and scope for Burlington. As part of this analysis, the City should examine the potential impacts of raising its stormwater fee. The current monthly user fee is $1.17 per thousand square feet of impervious surface.[34] The owner of a typical commercial lot with 20,000 square feet of impervious surface pays a fee of $23.40 per month. This relatively small fee gets buried within the larger water and sewer bill. As constructed, the user fee is too low to stimulate significant interest in earning green infrastructure credits, as evidenced by the lack of credits awarded by the program to date. As of the time of writing, only four green infrastructure credits have been awarded, and none have been granted in the downtown/waterfront area.

Increasing the user fee would likely make credits a more attractive option for property owners, particularly if it was paired with additional outreach to ensure that property owners understand the credit process. A number of cities have implemented stormwater use fees substantially higher than those in Burlington. For example, Portland, Oregon charges $9.97 per thousand square feet of impervious surface for non-residential properties.[35] If the City raises the user fee, it could consider adding waivers or discounts to assist those with financial difficulties.

The City could also consider developing cost-sharing opportunities or low-interest loan programs to help fund green infrastructure projects. For example, Task 3 presents a short case study on Philadelphia's Stormwater Management Incentives Program (SMIP), where commercial property owners can receive low-interest loans for stormwater management projects. Funded by the local water utility, loan amounts range from $75,000 to $1,000,000 with a one percent fixed interest rate. The loan term is up to 15 years, consistent with the payback period for stormwater management measures.

In addition, the Sustainable Cities Institute advocates that cities consider public-private partnerships for funding and maintaining green infrastructure. Private revenue or in-kind assistance options include 'Friends Of" programs, contributions to greenspace programs or funds, and donation of land or easements by private property owners.[36] For example, as discussed in the Task 3 memorandum, the Portland Green

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[33] Water Environment Research Foundation (WERF). "Portland, Oregon: Building a Nationally Recognized Program Through Innovation and Research." 2009. Available at: http://www.werf.org/livablecommunities/studies_port_or.htm

[34] Personal communication, Megan Moir, Burlington Department of Public Works. July 8, 2011.

[35] City of Portland, Oregon, Portland Bureau of Environmental Services. "Drainage/Stormwater Management User Service Charges and Discounts." Available at: http://www.portlandonline.com/bes/index.cfm?a=354259&c=55059.

[36] Sustainable Cities Institute. "Green Infrastructure Overview." Available at: http://www.sustainablecitiesinstitute.org/view/page.basic/class/tag.topic/community_support and http://www.sustainablecitiesinstitute.org/view/page.home/home;jsessionid=C0D6ECAA73256832D9995997B34B48B8

Streets programs is using a volunteer program, the Green Streets Steward Program, to maintain green infrastructure installations; the Stewards take responsibility for weed removal, plant trimming, and trash cleanup.

Develop an outreach and communication strategy. Burlington should invest in communication and outreach to for its sustainability programs, to market the concept of a Sustainable Burlington to stakeholders, including the local business community, existing and potential community members, and sister agencies. The Legacy Project Action Plan, which is scheduled to be updated in 2012, could provide a useful framework for discussion, linking the City's various sustainability-related policies and programs to broader issues of the City's long-term sustainability vision.

All stakeholders will benefit from Burlington centralizing information on its climate change and sustainability plan onto one well-designed, branded website (e.g., "LivableBurlington.gov"). Currently, to learn about related initiatives, one must go to different sites (e.g., DPZ's site and BED's site). Furthermore, the information presented on the DPZ site on the Climate Action Plan is not presented in an intuitive manner. The City's sustainability home page should explain what the City is trying to accomplish with its sustainability plan and should provide a compelling, concise argument about how climate action, livability, and economic stability are intrinsically linked for Burlington. The home page should provide links for more detailed information relevant to different stakeholders, much like the City's homepage does for residents, businesses and visitors. We recommend that Burlington hire a professional web design firm to develop this site. Burlington should also develop and post a pdf version of the Climate Action Plan for constituents who want to download the entire plan. Boulder County, Colorado has an effective sustainability homepage that Burlington could use as a template for this undertaking.[37] Seattle, Washington, which has a dedicated Office of Sustainability and Environment, is another example.[38]

Burlington's different stakeholder groups may need different types of information on the City's sustainability program:

- *Local business community:* Local businesses, especially those in the downtown/waterfront area, may want information on how sustainability initiatives can benefit their bottom lines by creating a more livable, vibrant, and economically stable downtown. Also, information on sustainability programs targeted at businesses, such as green building programs, should be organized in one spot on the website. Burlington may want to consider designating one City staff person as a liaison for businesses seeking information on sustainability programs, to act as a "one-stop-shop" for information.

  Local businesses will also benefit from reassurance that a lack of on-site parking will not negatively impact customer traffic. Prospectively, we suggest that Burlington provide case studies of other cities that have implemented similar parking plans. Also, businesses may be interested in information on residents' preferences for walking and transit; data showing that Burlington residents prefer a walkable downtown, and transit options may help to address concerns about parking. The City should contact the City of Boulder's GO Boulder staff to understand how they collect data underlying the program's annual report, which contains local data on walking, biking, and transit use (contacts are provided under separate cover).

- *Community members:* Existing and potential community members will need to understand the livability benefits of a more vibrant, pedestrian-friendly downtown, such as the ability to walk to

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[37] Boulder County. "About Sustainability." 2011. Available at: http://www.bouldercounty.org/sustain/initiative/pages/aboutsustain.aspx

[38] City of Seattle Office of Sustainability and Environment website. 2011. Available at: http://www.seattle.gov/environment/

work, services, and recreational amenities. Community members may be interested in the environmental benefits of sustainability initiatives, but the City should post such information in a way that resonates for average citizens. For example, in addition to reporting that the City's green building program will save a certain amount of energy, the City could add contextual information that the program will save enough energy to power a certain number of homes in Burlington for a year. Burlington may also want to summarize and present key findings from the growing body of literature on the connection between the built environmental and health, which indicates that people who live in walkable areas or take public transit tend to be healthier. Also, community members may also be interested in how sustainability initiatives position Burlington competitively, and may contribute to increased property values.

Similarly to businesses, some community members may have concerns with higher costs of parking resulting from Burlington's sustainability plans. The City should clearly explain on its website that it is using funds from parking revenues to make improvements in strategic parking facilities, public transportation, and any other sustainability programs funded by parking revenues.

- *Sister agencies:* Other agencies within City government may require information on how Burlington's sustainability initiatives fit into existing structures and procedures, how they are paid for, what the environmental benefits will be, and how sustainability initiatives position Burlington competitively vis-à-vis other cities. While some of this information may be appropriate for the City's sustainability website, other information needs from sister agencies may be more appropriately communicated over the City's intranet or another internal communication mechanism. In addition, DPZ and BED staff may want to hold meetings with other agencies to discuss the City's sustainability plans and provide requested details.

SECONDARY RECOMMENDATIONS

In addition to the major recommendations detailed above, we have also developed several additional recommendations for Burlington to consider. Below, we discuss additional recommendations for the four major issue areas: green buildings and energy efficiency, renewable energy, green infrastructure, and transportation.

Green Building and Energy Efficiency Recommendations

Implement and maintain stricter green building standards. Burlington's energy code requires that all new commercial and significantly renovated buildings meet 2005 Vermont Guidelines for Energy Efficient Commercial Construction.[39] These guidelines are based on the International Energy Conservation Code (IECC) 2004 Supplement, with amendments.[40] The Vermont legislature has recently passed legislation to update the guidelines based on the 2009 version of IECC and the 2007 version of ASHRAE 90.1.[41] BED is awaiting a final rulemaking to formalize the update, expected in January 2012.[42]

[39] City of Burlington Code of Ordinances, 8-101 Conservation Standards.

[40] Database of State Incentives for Renewables & Efficiency. "Vermont Building Energy Standards." Available at: http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=VT07R&re=1&ee=1.

[41] Overall, the 2009 IECC standard has higher insulation requirements and higher energy efficiency requirements for heating, ventilating and air-conditioning (HVAC) equipment. Huang, Y. and K. Gowri. "Analysis of IECC (2003, 2006, 2009) and ASHRAE 90.1-2007 Commercial Energy Code Requirements for Mesa, AZ." Prepared for the US Department of Energy. February 2011. Available at: http://www.mesaaz.gov/sustainability/pdf/MesaFinalCommercialReportFeb2011.pdf.

[42] Personal Communication, Chris Burns, Burlington Electric Department, July 25, 2011.

This lag at the state level has resulted in Burlington and other cities in Vermont waiting to adopt the most up-to-date energy code. We recommend Burlington take action to avoid this problem and keep the City on the leading edge of energy efficiency. Massachusetts has confronted this problem with two approaches that Burlington could consider:

- *Keep Burlington's energy code state-of-the-art*. The Massachusetts Green Communities Act of 2008 requires that the State update its building code every three years to be consistent with the most recent version of IECC.[43] Similarly, rather than wait for legislative action, Burlington could amend its code to pin to the latest version of IECC and ASHRAE 90.1. Both IECC and ASHRAE 90.1 are being updated every three years.

  One of the Spring Hill Solutions' key recommendations regarding Burlington's Climate Action Plan was to require new commercial construction to meet the requirements of Core Performance, an energy efficiency program established by Efficiency Vermont. Core Performance is a prescriptive set of measures intended to reduce energy use in commercial buildings 20 – 30 percent below ASHRAE 90.1-2004.[44] Following Spring Hill Solutions' recommendation could raise the baseline for energy efficiency beyond the current requirements of IECC or ASHRAE. However, requiring both Core Performance and the most recent version of IECC and ASHRAE may be needlessly burdensome, and the City may want to choose one approach over the other. It is unclear how often, if at all, the Core Performance requirements will be revised. Thus, an approach based on IECC and ASHRAE may produce more efficiency gains over the long term.

- *Implement a "stretch" code.* Stretch codes provide an avenue to improve efficiency by emphasizing energy performance, as opposed to the prescriptive requirements common in building energy codes. Typically, a stretch code requires performance that goes beyond existing code. In Massachusetts, communities that choose to employ the stretch code must build 20 percent more energy efficient than the base energy code.[45] The State estimates that the additional construction costs resulting from the stretch code runs approximately $3,000 for a typical single-family home, and one to three percent of total costs for commercial buildings.[46]

As an alternative to the either of the above options, Burlington could require new commercial construction to meet more broad-based green building standards. Again, it may be overly burdensome to require a green building standard in addition to strict energy efficiency guidelines, and Burlington may want to choose one strategy over the other. The decision should be guided by whether the City is concerned primarily with energy efficiency or with the broader range of building environmental impacts. If Burlington is interested in adopting a green building standard, we recommend either LEED or the International Green Construction Code (IgCC). LEED for New Construction is the most widely used

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[43] Massachusetts Executive Office of Energy and Environmental Affairs. "Building Energy Codes." Available at: http://www.mass.gov/?pageID=eoeeaterminal&L=4&L0=Home&L1=Energy%2c+Utilities+%26+Clean+Technologies&L2=Energy+Efficiency&L3=Policies+and+Regulations+for+Energy+Efficiency&sid=Eoeea&b=terminalcontent&f=doer_Energy_Efficiency_Building_energy_Codes&csid=Eoeea.

[44] Advanced Buildings and Efficiency Vermont. "Core Performance Guide: Vermont Edition." January 2008. Available at: http://www.efficiencyvermont.com/docs/for_my_business/new_construction/CorePeformance_VermontEdition.pdf

[45] Massachusetts Executive Office of Energy and Environmental Affairs. "Building Energy Codes." Available at: http://www.mass.gov/?pageID=eoeeaterminal&L=4&L0=Home&L1=Energy%2c+Utilities+%26+Clean+Technologies&L2=Energy+Efficiency&L3=Policies+and+Regulations+for+Energy+Efficiency&sid=Eoeea&b=terminalcontent&f=doer_Energy_Efficiency_Building_energy_Codes&csid=Eoeea.

[46] Massachusetts Executive Office of Energy and Environmental Affairs. "Stretch Appendix to the Building Energy Code in Massachusetts Question and Answer (Q&A) – October 2010. " October 2010. Available at: http://www.mass.gov/Eeops/docs/dps/inf/stretch_energy_code_qa_oct11_10.pdf.

green building standard in the U.S., and is generally regarded as a robust set of requirements. In addition, Burlington already has some experience, albeit limited, with LEED; current incentives allow for bonus height if the building is certified as LEED Silver or higher. Numerous communities throughout the U.S. have required new construction to meet LEED standards, including Boston, Los Angeles, Dallas, and Washington, DC. Given the expense associated with certification, these cities opted not to require formal certification; rather, city code officials typically evaluate documentation of a building's LEED characteristics before granting final occupancy permits.[47] Some cities, such as Los Angeles, expressed concern that requiring formal certification could create legal challenges and open them up to lawsuits, since building permits or occupancy certificates would be contingent on judgments made by the U.S. Green Building Council (USGBC), which administers LEED.[48]

Among the numerous competing systems, we believe the IgCC is likely to be the dominant alternative to LEED in the future, especially for policy actions. At this point, IgCC is still in draft form; the first public version was released in 2010, and the ICC expects to publish the first approved version in March 2012. Some local governments have adopted the draft version of the code within the last year. The fact that the requirements of the code are still in flux, and that there is little implementation experience, means that adopting the IgCC may be somewhat riskier than LEED for Burlington. In general, IgCC and LEED appear to have similar levels of stringency, but the two do have some distinguishing characteristics. Most notably, as a point-based system, LEED places a greater emphasis on optional practices, whereas IgCC is driven more by requirements.[49] This allows building projects greater flexibility under LEED than IgCC, but it also means LEED buildings may have less uniform energy performance. Both systems allow either prescriptive measures or a performance-based approach to energy efficiency. However, where LEED's requirements are geared off the ASHRAE 90.1 standard, IgCC references the International Energy Conservation Code (IECC). Nevertheless, IgCC also provides for alternative means of compliance (e.g., the ASHRAE standard discussed below, or being in the top 10 percent of existing buildings using EPA's Target Finder).

Other well-known green building standards include the National Association of Homebuilders (NAHB) and ASHRAE 189.1. The NAHB standard is not as stringent in all areas as LEED or IgCC. For instance, in a comparison of NAHB to LEED for Homes (the most directly comparable LEED standard), the Cincinnati chapter of AIA found that one of the key differences between the two standards was that LEED had more stringent minimum performance requirements with respect to energy. The researchers also found LEED to have more rigorous documentation requirements and definitions of key terms, resulting in more clearly defined requirements.[50] In addition, the NAHB standard applies only to residential buildings. Thus, relying on NAHB alone would therefore leave Burlington without an effective way to evaluate commercial or mixed-use buildings. As such, we do not recommend using the NAHB standard. ASHRAE 189.1, another relatively new system, is roughly on par with IgCC with respect to stringency, and similarly focuses on requirements rather than optional practices. However, since IgCC

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[47] USGBC. "Summary of Government LEED® Incentives" March 2009. Available at: http://www.usgbc.org/ShowFile.aspx?DocumentID=2021.

[48] Wendt, A. "Cities Mandate LEED But Not Certification. GreenSource. July 30, 2008. Available at: http://greensource.construction.com/news/080730CitiesMandateLEED.asp.

[49] IgCC does contain some optional practices, but these are mostly *jurisdictional requirements*, i.e., practices that adopting jurisdictions (cities and states) decide whether or not to require for all buildings.

[50] AIA Cincinnati. "Comparison of United States Green Building Council's LEED for Homes First Edition 2008 and National Association of Home Builders' National Green Building Standard ICC 700-2008. January 2010. Available at: http://www.aiacincinnati.org/community/LEED_NAHB_Final.pdf

allows ASHRAE 189.1 as an alternative compliance pathway, adopting IgCC would allow builders the option to use ASHRAE 189.1 if they so choose.

Green historic preservation. Burlington's downtown/waterfront area features many historic buildings. While these buildings are important to the character of the area, they pose particular challenges with respect to energy use, especially because Vermont's energy code exempts historic buildings from energy efficiency requirements.[51] EPA and others have undertaken initiatives to yield potential strategies for retrofitting historic buildings for energy efficiency. Burlington officials should contact experts from these programs to obtain guidance on implementing a green historic preservation program in Burlington. Connecting with experts with this area will be particularly important given that a large proportion of planned POWER projects in the City could be at historic buildings.

Of particular note, EPA, HUD, and DOT are providing technical assistance to Concord, New Hampshire, working with community officials, developers, and other stakeholders to determine how historic preservation and green building approaches can best be integrated into existing codes. One goal of the project is to provide guidance on the how to design a regulatory framework that supports the sustainable, green redevelopment of historic buildings. Given the similarities between the two cities, outcomes from this project could assist Burlington in amending its code to account for historic properties.[52]

Other resources that could aid Burlington in developing a green historic preservation initiative include:

- EPA hosts an annual symposium to discuss how to sustainably retrofit existing buildings.[53]
- The Advisory Council of Historic Preservation has developed guidance on integrating sustainability with historic preservation for federal buildings.[54]
- The City of Boulder, Colorado has developed a suite of materials targeting energy efficiency in historic buildings, with detailed technical guidance.[55]

Integrate energy efficiency into the capital planning process. We have discussed above the potential value of a concerted effort to re-commission older buildings to ensure optimal energy performance. One means of achieving this would be for City officials to work to include energy efficiency considerations as an integral part of the capital planning process for municipal buildings. We understand that the Department of Public Works (DPW) is already engaging with BED on a limited basis to address efficiency improvements to municipal buildings, but we recommend that the City consider a more systematic approach that makes use of existing maintenance plans and procedures.

As discussed in the Task 3 memorandum, the City of Berkeley, California may provide a useful model for Burlington in this regard. In Berkeley, the Office of Energy and Sustainable Development (OESD) has placed a high priority on making municipal buildings more energy efficient. When OESD first began undertaking efficiency retrofits of municipal buildings in the 1990s, there was little communication with other departments about these projects. Over the years, OESD realized that coordination with the

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[51] Personal Communication, Chris Burns, Burlington Electric Department, July 11, 2011.

[52] U.S. Environmental Protection Agency. "Smart Growth and Sustainable Preservation of Existing and Historic Buildings." Available at: http://www.epa.gov/smartgrowth/topics/historic_pres.htm.

[53] U.S. Environmental Protection Agency. "Region 5 Brownfields." Available at: http://www.epa.gov/R5Brownfields/.

[54] Advisory Council on Historic Preservation. "Sustainability and Historic Buildings. May 2011. Available at: http://www.achp.gov/docs/SustainabilityAndHP.pdf.

[55] City of Boulder, Colorado. "Historic Building Energy Efficiency Guide." Available at: http://www.bouldercolorado.gov/index.php?option=com_content&task=view&id=8217&Itemid=22.

Department of Public Works (DPW) was particularly beneficial, and as a result, maintenance projects now routinely include consideration of energy efficiency upgrade opportunities. OESD works cooperatively with the DPW to identify opportunities to incorporate energy efficiency measures into already-scheduled building maintenance activities. Examples of retrofits include updated lighting and occupancy sensors for lights, more efficient heating and ventilation systems, and better control systems.

To implement this recommendation, Burlington should identify key experts, potentially in BED and/or DPZ, to work with DPW on an ongoing basis to integrate efficiency improvements into existing building maintenance plans. Within the capital planning process, building investment decisions should be guided by clear criteria that will advance the City's sustainability policy. Criteria should include the potential for energy and greenhouse gas reductions, technical ease of implementation, flexibility to adapt to different conditions over time, and lifecycle cost. In many organizations, budgeting decisions are made predominantly based on capital costs, with little or no consideration given to operating costs; this approach inevitably leads to missed opportunities for long-term savings. In contrast, investments should be evaluated on a lifecycle cost basis. One method to mitigate potential capital constraints, at least after an initial startup period, would be to redirect utility bill savings from efficiency improvements into a dedicated fund for future efficiency measures; this would help to bridge the divide between capital and operating budget impacts.

Renewable Energy Recommendations

Focus on efficiency first. For several reasons, we recommend that Burlington use renewable energy generation as a secondary strategy to energy efficiency. In most cases, renewable energy generation is not as cost-effective as energy efficiency measures in reducing GHG emissions. This is especially true in locations such as Burlington with an older building stock. Furthermore, while superior to fossil fuels, renewable energy sources have their own environmental impacts, primarily associated with the manufacturing and end-of-life stages. Renewables can also be more logistically challenging to implement on a distributed (i.e., non-utility scale) basis, since they may require greater coordination with the electric utility or with regulators. While BED has stated its goal of meeting 100 percent of its generation needs from renewable sources by 2012, meeting this goal will be more feasible and affordable if the City first takes aggressive steps to reduce electricity demand.[56]

Burlington's Climate Action Plan appears to reflect this prioritization. Several renewable energy items are included in the plan, but in Spring Hill Solutions' final ranking of the proposed actions, the highest-priority actions are primarily efficiency-related. These proposed efficiency measures focus on setting strict efficiency standards for new construction and incentivizing residential efficiency renovations. While certain renewables programs, such as the proposed "Solar on Schools" initiative, could play a role in reducing Burlington's environmental impacts, we support the general approach promoted by Spring Hill Solutions of emphasizing efficiency first.

Conduct additional feasibility analyses on renewable energy, and integrate the results of these analyses into the form-based code. An emphasis on efficiency notwithstanding, to the extent that efficiency strategies alone are insufficient to meet the City's goals, Burlington should undertake additional feasibility analyses to determine which renewable energy resources are most appropriate for deployment in the downtown/waterfront area. As suggested above, the City could use form-based codes (FBCs) as a

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[56] Burlington Electric Department. "Power Supply: BED's Power Supply for 2010." July 14, 2011. Available at: https://www.burlingtonelectric.com/page.php?pid=128&name=BED%27s%20Power%20Supply

means to guide the placement and installation of renewables at the property level. A key challenge to incorporating renewables into FBCs is the need to develop a deep understanding of the energy resources and equipment types that makes economic and physical sense for the area. The City should aim to understand the best locations for renewable energy installations and the types of systems that are best suited to each geographic area. Without this information, the City could potentially permit improper siting of renewables. The City should therefore consider an extensive review, focusing on highly localized characteristics, to determine the site locations, technologies, and renewable resources that are most viable for renewable energy production. As discussed in our Task 1 memorandum, Flagstaff, Arizona undertook such a review when developing its own FBC that could serve as a model for Burlington.[57,58]

Thus far, the City has shown the most interest in the installation of solar power. The National Renewable Energy Laboratory estimates that the solar potential in Burlington is approximately 1,500 kilowatt-hours per square meter per year. While this output is relatively low compared to many parts of the nation, it still allows for successful solar installation under the right conditions.[59] The City has had success with the installation of solar photovoltaic (PV) arrays and solar hot water heaters, with at least 28 solar roofs installed. Geothermal energy is another potential renewable resource for the City to consider. The upfront costs of geothermal energy vary greatly, depending on a number of factors, including site geology, property size, building size, system type, well depth, and the potential updates necessary to make the building capable of handling geothermal energy (typically older buildings need new insulation). For both geothermal and solar power, additional feasibility analyses would be necessary for the City to develop FBCs that effectively guide the location and characteristics of renewable energy installations.

While the City has also expressed interest in wind energy, it does not appear that wind installations will be economically viable in the downtown/waterfront area. A recent study conducted by the Carbon Trust found that small urban wind turbines are typically mounted at relatively low heights and are not usually in a position to catch enough wind to generate a substantial amount of electricity. At low generation rates, the cost of electricity becomes very high. The researchers also found that the carbon footprint associated with manufacturing, shipping, installing, and maintaining small urban wind turbines can be greater than GHG emissions from energy production at local power stations.[60,61] We recommend that Burlington to defer pursuing wind energy until it can be reliably demonstrated in urban settings similar to the downtown/waterfront area.

Green Infrastructure Recommendations

Create a green roofs program. Green roofs are made of dense vegetation planted on the roofs of buildings. They are designed to reduce the stormwater impacts of development through the detention and retention of stormwater, and can be particularly useful in highly urbanized areas with high levels of impervious surface. A recent EPA study indicates that green roofs are capable of removing 50 percent of

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[57] Parolek, D. "Form-Based Codes and Sustainability: Two Case Studies." Presentation at the New Partners for Smart Growth Workshop. Charlotte, NC. February 3, 2011.

[58] For more information on the Flagstaff form-based code, see http://www.flagstaff.az.gov/index.aspx?NID=1416.

[59] National Renewable Energy Laboratory. "Photovoltaic Solar Potential in the United States." 2008. Available at: http://www.nrel.gov/gis/solar.html.

[60] Page, L. "Carbon Trust: Rooftop windmills are eco own-goal." The Register. August 7, 2008. Available at: http://www.theregister.co.uk/2008/08/07/rooftop_wind_turbines_eco_own_goal/page2.html.

[61] Researchers at the Wind Energy Integration in the Urban Environment (WINEUR) have demonstrated that under the right conditions, small-scale urban wind can produce economically viable power; however, they call for turbine mast or building height that are 50 percent taller than the surrounding buildings. These conditions are unlikely in the downtown/waterfront area of Burlington. Wind Energy Integration in the Urban Environment. "Urban Wind Turbines: Guidelines for Small Wind Turbines in the Built Environment." February 2007. Available at: http://www.urbanwind.net/pdf/SMALL_WIND_TURBINES_GUIDE_final.pdf.

the annual rainfall volume from a roof through retention and evapotranspiration. Rainfall not retained by green roofs is detained, increasing the time to peak and slowing peak flows for a watershed.[62] Burlington's city code encourages green infrastructure practices, including green roofs, but the code is silent with regard to appropriate use and application of green roofs in the City.[63] Currently, the City approves green roofs (along with several other green infrastructure measures) on a case-by-case basis.

Impediments to green roofs in Burlington include the lack of familiarity with the technique, difficulty locating technical expertise, and installation and maintenance costs.[64, 65] A green roofs initiative could help bridge some of the information gaps, bring together interested parties with experts and advocates, and provide incentives through user fee credits or other green infrastructure funding mechanisms (such as loans and grants). As one model of such a program, Cincinnati has dedicated an estimated $5 million per year in below-market-rate loans from the U.S. Environmental Protection Agency's Clean Water State Revolving Fund to cover the incremental cost of adding a green roof to a new or existing building.[66]

Consider urban forestry a form of green infrastructure. Urban street trees provide significant stormwater management benefits.[67] They also face tremendous stress from inadequate soils, pollution, and human interference, which can dramatically reduce life span. They require regular maintenance and attention, which can be resource intensive and time consuming. Despite these benefits and maintenance requirements, Burlington's urban forestry is not managed as a green infrastructure resource. Rather, the program is the responsibility of the Parks and Recreation Department, and is funded through the general fund and a dedicated tax built into local property taxes at $0.0026 per $1.00 in assessed value.[68]

The Department is currently in the midst of conducting a new urban tree inventory, which will identify the location, ages, species, health of Burlington's nearly 10,000 trees, including those in the downtown/ waterfront area. This inventory is the first step in the updating the urban forestry master plan and street tree planting plan.[69] The City's Stormwater Management Program could leverage and provide input into these plans to ensure that the planting strategies maximize stormwater retention in the downtown/ waterfront area. This broader view of what constitutes green infrastructure would require close collaboration between DPZ and Parks and Recreation, including sharing GIS data on the tree inventory and existing stormwater management measures, and potentially some redefinition of program goals.

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[62] U.S. EPA. "Green Roofs for Stormwater Runoff Control." February 2009. EPA/600/R-09/026. Available at http://www.epa.gov/nrmrl/pubs/600r09026/600r09026.pdf.

[63] City of Burlington Code of Ordinances, Section 26-157: Use of alternative stormwater management practices. Available at: http://library.municode.com/index.aspx?nomobile=1&clientid=13987

[64] Cost estimates for green roofs range widely, ranging from $6 per square-foot to over $40 square-foot, based on the size of the roof, new construction versus an existing building, method of installation, and roof type. U.S. EPA. "Green Roofs for Stormwater Runoff Control." February 2009. EPA/600/R-09/026. Available at: http://www.epa.gov/nrmrl/pubs/600r09026/600r09026.pdf.

[65] Personal communication, Mark Eldridge, Green roof advocate, July 8, 2011.

[66] City of Cincinnati. Office of the City Manager. Green Roof Program. Available at: http://www.cincinnati-oh.gov/cmgr/pages/-38098-/.

[67] Street trees also provide additional benefits, including pollutant removal, cooling, wildlife habitat, safety, and aesthetics. The USDA estimates that over a 50-year lifetime, a street tree generates $31,250 worth of oxygen, provides $62,000 worth of air pollution control, recycles $37,500 worth of water, and controls $31,250 worth of soil erosion. USDA Forest Service Pamphlet #R1-92-100. For a thorough discussion on the benefits of street trees, see Burdan, Dan. "22 Benefits of Urban Street Trees." May, 2006. Available at: http://www.ufei.org/files/pubs/22BenefitsofUrbanStreetTrees.pdf.

[68] City of Burlington, Vermont. "Resolution Relating to Annual Tax Assessments on the Property Grand List of the City for the Purposes therein Set Forth for the Fiscal Year Beginning July 1, 2011." Available at: http://www.ci.burlington.vt.us/docs/4846.pdf.

[69] Personal communication, Warren Spinner, Burlington Parks and Recreation Department, July 25, 2011.

Transportation Recommendations

Review existing transportation assumptions and performance metrics. In the Task 2 memorandum, IEc reviewed the literature to evaluate the potential energy and GHG emission reduction benefits that Burlington could realize through more compact development and lower vehicle miles traveled (VMT). It was not within the scope of this project for IEc to perform a detailed analysis of the assumptions underpinning Burlington's Climate Action Plan or Transportation Plan to ascertain whether they are consistent with the results we found from the literature. However, we recommend that Burlington undertake such a review and, if necessary, amend its policy efforts accordingly. For example, as noted previously, the literature indicates that changes in residential density alone are not likely to drive significant reductions in VMT; other community characteristics, such as distance to key destinations, street design, and transit access appear to be more important. Burlington should verify that its climate and energy efforts incorporate the best data currently available in the literature on this issue.

The Task 2 memorandum also provided recommendations on metrics and data sources that the City can use to measure environmental impacts, summarized in Exhibit 1 below. Burlington's recently adopted Transportation Plan includes several progress indicators intended to track the City's performance over time; however, it does not provide any details on how this information will be collected. These indicators include the following:

- Transit ridership;
- Traffic volumes into and out of the City;
- Transportation Management Association (TMA) employee mode shares; and
- Energy use/GHG emissions.[70]

From an environmental perspective, energy use and GHG emissions are the most important metrics among those listed. The others are secondary indicators that provide additional detail on particular strategies to reduce transportation energy use. We recommend using the Vermont sample from the National Household Travel Survey (NHTS) as a data source for VMT. Continuing to measure this over time will help City officials gauge success in reducing overall levels of driving. Translating this into more direct environmental impacts, the literature suggests that every one VMT decreased should result in a net decrease of 0.86 – 0.93 lb. CO_2.

[70] City of Burlington Department of Public Works, Department of Planning and Zoning, and Community Economic Development Office. "Moving Forward Together: Transportation Plan for the City of Burlington." Adopted March 28, 2011, p. 11. Available at: http://www.ci.burlington.vt.us/docs/4593.pdf

EXHIBIT 1: SUMMARY OF LOCAL-LEVEL METRICS FOR BURLINGTON

GENERAL ENVIRONMENTAL BENEFIT	BURLINGTON BASELINE DATA	POTENTIAL BURLINGTON ENVIRONMENTAL BENEFIT	BURLINGTON DATA SOURCE
20 – 40 percent household-level VMT reduction from compact development	9,500 VMT per person per year (total)	1,900 – 3,800 VMT per person per year	Chittenden County/Vermont NHTS add-on sample
	0.86 – 0.93 lb. CO_2 per VMT	1,634 – 3,534 lb. CO_2 per person per year	N/A (value from literature)
Total CO_2 reduction from bus ridership	Unknown	Calculated per Exhibit 2	CCTA
4.4 percent residential energy savings from moving from a larger detached home to a smaller detached home	5,190 kWh electricity per residence per year (total)	228 kWh electricity per residence per year	Burlington Electric Department
	0.497 lb. CO_2 per kWh	113 lb. CO_2 per residence per year from electricity	Burlington Electric Department (fuel mix); EPA (emissions factors)
	900 ccf gas per residence per year (total)	40 ccf gas per residence per year	Vermont Gas
	12 lb. CO_2 per ccf gas	480 lb. CO_2 per residence per year from gas	N/A (value from literature)
20 - 37 percent residential energy savings from moving from a larger detached home to smaller apartment	5,190 kWh electricity per residence per year (total)	1,038 – 1,920 kWh electricity per residence per year	Burlington Electric Department
	0.497 lb. CO_2 per kWh	516 – 954 lb. CO_2 per residence per year from electricity	Burlington Electric Department (fuel mix); EPA (emissions factors)
	900 ccf gas per residence per year (total)	180 - 333 ccf gas per residence per year	Vermont Gas
	12 lb. CO_2 per ccf gas	2,160 – 3,996 lb. CO_2 per residence per year from gas	N/A (value from literature)

We also provide a method for estimating environmental benefits from increased transit ridership in the Task 2 memorandum, reproduced below in Exhibit 2. That calculation requires an estimate of total passenger-miles per year from CCTA.

EXHIBIT 2: CALCULATING ENVIRONMENTAL GAINS FROM PUBLIC TRANSPORTATION

ROW	CALCULATION STEP	CURRENT VALUE	DATA SOURCE
[1]	Total Bus Gallons (Diesel) Consumed	372,534	CCTA
[2]	/ Total Bus Passenger-Miles	Unknown	CCTA
[3]	= Bus Gallons (Diesel) per Person-Mile	[1] / [2]	Calculated
[4]	x CO_2 per Gallon (Diesel)	22.2 lb.	EPA
[5]	= Bus CO_2 per Person-Mile	[3] x [4]	Calculated
[6]	Automobile Gallons (Gasoline) per Person-Mile	0.03	U.S. Average
[7]	x CO_2 per Gallon (Gasoline)	19.4 lb.	EPA
[8]	= Automobile CO_2 per Person-Mile	[6] x [7] = 0.582 lb.	Calculated
[9]	Net CO_2 Reduction per Passenger-Mile from Riding Bus	[8] – [5]	Calculated
[10]	Total CO_2 Reduction from Riding Bus	[9] x [2]	Calculated

Increase service frequency for City Loop bus route. As noted above, the CCTA plans to increase service frequency on the four major bus routes bringing passengers into Burlington. The organization may also want to consider increasing the frequency of the City Loop route in particular. The City Loop route had 99,146 riders in FY2010. This made it the CCTA's ninth-most popular route out of 26, suggesting it is a significant but not a dominant aspect of the city's transit service.[71] Improving the service frequency of the other bus routes noted above may increase the number of commuters that choose to use public transit rather than driving into downtown from surrounding areas, but it may not have much influence on the behavior of downtown residents, who may have little reason to take the bus to outlying areas. Increasing service frequency on the City Loop route, on the other hand, could have a greater impact on reducing levels of automobile ownership and use among downtown/waterfront residents. More importantly, in addition to the direct effect on the travel patterns of current residents, the added convenience of more frequent bus service within the downtown/waterfront area could be an important selling point in persuading potential residents to choose to live downtown.

In Boulder, the Community Transit Network buses (i.e., the HOP, SKIP, and JUMP), which run so frequently that schedules are not needed, are a critical part of that city's transit strategy. Emulating the Boulder model for the City Loop could help Burlington to achieve greater levels of transit ridership. In Boulder, as in Burlington, the main bus system is not operated by the city. Boulder supplemented the Regional Transportation District (RTD) buses with its own system, because RTD would not provide increased service on the downtown loop. If feasible, a better method would be for Burlington to work with CCTA and/or provide incentives for CCTA to increase service on the existing City Loop route.

Consider switching the CCTA bus fleet to biodiesel. Finally, we suggest that Burlington work with CCTA to reduce the GHG emissions of its fleet by switching to biodiesel, either as a blend with conventional diesel or as a replacement. Biodiesel could be used by existing buses with little or no modification. Natural gas would also be an option, but given that CCTA has replaced half of its fleet since 2007,[72] retrofits to natural gas are unlikely to be cost-effective at this time.

CCTA began using a 20 percent biodiesel blend in 2007 but suspended its use in February 2011 due to concerns about the high price of diesel fuel; the agency's fuel costs were higher than budgeted, and the biodiesel blend had been costing an additional $0.11 per gallon above conventional Ultra-Low Sulfur Diesel (ULSD). Nevertheless, the agency has indicated that it would prefer to resume using biodiesel if possible.[73] In FY2011, CCTA buses consumed a total of 372,534 gallons of fuel. This implies a total cost premium of about $41,000 annually for the 20 percent biodiesel blend.[74]

A National Renewable Energy Laboratory study found that, over its lifecycle, pure biodiesel has CO_2 emissions 78.5 percent lower than petroleum-based diesel. A 20 percent blend reduces emissions by 15.7 percent.[75] Burlington should evaluate the cost of such emissions reductions relative to other proposed activities in its Climate Action Plan. If the cost of emissions reductions from biodiesel is favorable, the City may want to consider subsidizing CCTA or providing other incentives to resume biodiesel use.

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[71] Chittenden County Transportation Authority. Ridership Summary for FY10. Provided by Jon Moore, Transit Planner, Chittenden County Transportation Authority, July 6, 2011.

[72] Chittenden County Transportation Authority. "Transit Development Plan: Executive Summary." September 2010. Available at: http://www.cctaride.org/pdf/Documents/ExecutiveSummary.pdf

[73] Chittenden County Transportation Authority. "Chittenden County Transportation Authority Suspends Use of Biodiesel to Cut Costs." February 25, 2011. Available at: www.cctaride.org/pdf/press-releases/CCTASavesonFuelCosts.pdf

[74] Data provided by Jon Moore, Chittenden County Transportation Authority, July 19, 2011.

[75] National Renewable Energy Laboratory. "An Overview of Biodiesel and Petroleum Diesel Life Cycles." NREL/TP-580-24772. May 1998. Available at: http://www.nrel.gov/vehiclesandfuels/npbf/pdfs/24772.pdf